HP 1821A

1821A TIME BASE AND DELAY GENERATOR

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

HP 1821A

HEWLETT hp PACKARD

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period. No other warranty is expressed or implied. We are not liable for consequential damages.

For any assistance contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

MODEL 1821A
TIME BASE AND DELAY GENERATOR

SERIALS PREFIXED: 611-

02591-1

PRINTED: JULY 1966

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

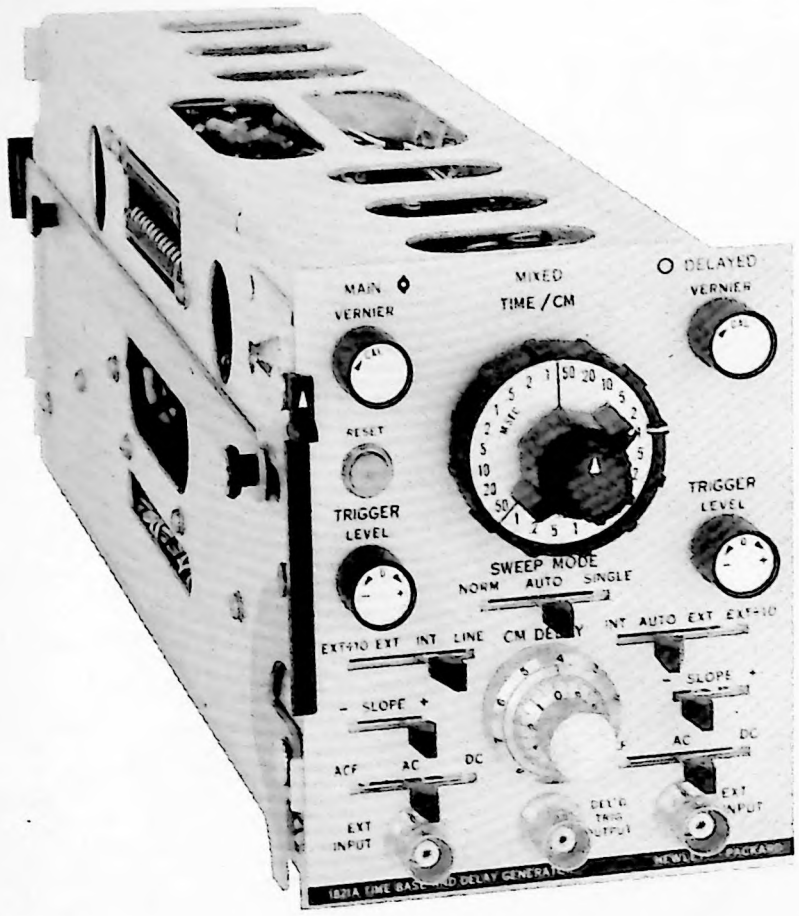


Figure 1-1. Model 1821A Time Base and Delay Generator

Table 1-1. Specifications.

MAIN SWEEP:

Range: 22 ranges, 0.1μsec/cm to 1 sec/cm in 1, 2, 5 sequence; accuracy, ±3%; vernier provides continuous adjustment between ranges and extends slowest sweep to at least 2.5 sec/cm; horizontal magnifier expands fastest sweep to 10 nsec/cm.

Triggering:

Internal: See vertical amplifier plug-in.

External: DC to 50 MHz from signals-0.5v p-p or more increasing to 1v at 90 MHz.

Automatic: Bright base line displayed in absence of an input signal. Internal, from 40 Hz, see vertical amplifier specification. External, from 40 Hz on signals 0.5v p-p or more to greater than 50 MHz, increasing to 1v at 90 MHz.

Trigger point and slope: Controls allow selection of level and positive and negative slope; trigger level on external sync signal adjustable over range of ±5 volts, ±50v in ÷ 10 position.

Coupling: AC, DC, ACF; AC attenuates signals below approximately 20 Hz; ACF attenuates signals below approximately 15 kHz.

Trace Intensification: Used for setting-up delayed or mixed sweep. Increases in brightness that part of main sweep to be expanded full screen in delayed sweep or made magnified part of display in mixed sweep; Rotating Delayed Sweep time switch from OFF position activates intensified mode.

DELAYED SWEEP:

Delayed time base sweeps after a time delay set by main sweep and delay controls.

Range: 18 ranges, 0.1μsec/cm to 50 msec/cm in 1, 2, 5 sequence; accuracy, ±3%; vernier provides continuous adjustment between ranges and extends slowest sweep to at least 125 msec/cm.

Triggering: Applied to intensified Main, Delayed and Mixed Sweep modes.

Automatic: Delayed sweep starts at end of delayed period.

Internal, External, Slope, Level, and Coupling: Same as Main Sweep triggering.

Delay (before start of delayed sweep):

Time: Continuously variable from 0.1μsec to 10 sec.

Accuracy: ±1%, linearity, ±.2%; time jitter is less than 0.005% of maximum delay of each range (1 part in 20,000).

Trigger Output (at end of delay time): Approximately 1.5v with less than 50nsec rise time from 1k ohm impedance.

MIXED SWEEP:

Dual sweep display in which main sweep drives first portion of display and delayed sweep completes display at speeds up to 1000 times faster.

SINGLE SWEEP:

Any display may be operated in Single Sweep.

WEIGHT:

Net, 3-3/4 lbs (1,7kg).

Shipping, 6-1/4 lbs (2,8kg).

SECTION I
GENERAL INFORMATION

1-1. INSTRUMENT DESCRIPTION.

1-2. The Hewlett-Packard Model 1821A Time Base And Delay Generator (shown in Figure 1-1) is a sweep generating plug-in unit for the hp Model 180A/AR Oscilloscope. Main sweep speeds are selectable in 22 ranges from 0.1 μsec/cm to 1 sec/cm. A vernier provides continuous adjustment between ranges and will extend the slowest sweep speed to at least 2.5 sec/cm. The Model 180A/AR horizontal magnifier can extend the fastest sweep speed to 10 nsec/cm. Delayed sweep time speeds can be selected with 18 ranges from 0.1 μsec/cm to 50 msec/cm; the delayed vernier provides continuous adjustment between ranges and extends the slowest sweep speed to at least 125 msec/cm. The main and delayed sweeps can be used either separately or combined to obtain a dual sweep-speed display.

1-3. The delayed sweep feature of the Model 1821A permits accurate time measurement between a reference signal and a point of interest on a complex waveform or pulse train; it also allows for exact time interval measurement between consecutive pulses in a pulse train or burst. The length of time before the delayed sweep starts is adjustable. The mixed sweep feature permits viewing simultaneously the character of an entire complex waveform and an expanded portion of the same waveform.

1-4. Single sweep operation is possible for any type of display. This feature may be used with any sweep speed to facilitate transient waveform photography. Normal triggering of the Model 1821A main sweep and delayed sweep may be selected to occur on an internal signal from the vertical plug-in or on an external signal up to 90 MHz (requires 0.5v pk-pk up to 50 MHz, increasing to 1v at 90 MHz). For the main sweep, automatic triggering provides a bright base line in the absence of an input signal; for the delayed sweep, automatic triggering starts this sweep at the end of the delayed period set. Trigger slope level, and coupling are controlled from the front panel for both the main and delayed sweeps. Table 1-1 provides complete specifications for the Model 1821A and Figure 1-2 illustrates typical displays obtainable with the plug-in.

1-5. SCOPE OF MANUAL.

1-6. This manual provides operating and service information for the hp Model 1821A Time Base And Delay Generator. This manual supplements the information presented in the Operating and Service Manual for the hp Model 180A/AR Oscilloscope. For information on other plug-ins for the Model 180A/AR, refer to the manual for the specific plug-in unit.

1-7. INSTRUMENT IDENTIFICATION.

1-8. Hewlett-Packard uses a two-section eight-digit serial number to identify instruments. The first three digits (preceding the dash) are the serial prefix which identifies a series of instruments; the last five digits identify a particular instrument in the series. The serial number appears on a plate located on the rear panel. All correspondence with a Hewlett-Packard Sales/Service Office in regard to an instrument should reference the complete serial number.

1-9. MANUAL CHANGES.

1-10. This manual provides complete information for any Model 1821A with a serial number prefixed (see Paragraph 1-7) by the three digits indicated on the title page. If the serial prefix of the instrument is different from that on the title page, a "Manual Changes" sheet supplied, or Section VII of this manual, will describe changes which will adapt this manual to provide correct coverage. Technical corrections (if any) to this manual, due to known errors in print, are called Errata and are shown on the change sheet. For information on manual coverage of any hp instrument, contact the nearest hp Sales/Service Office (addresses are listed at the rear of this manual).

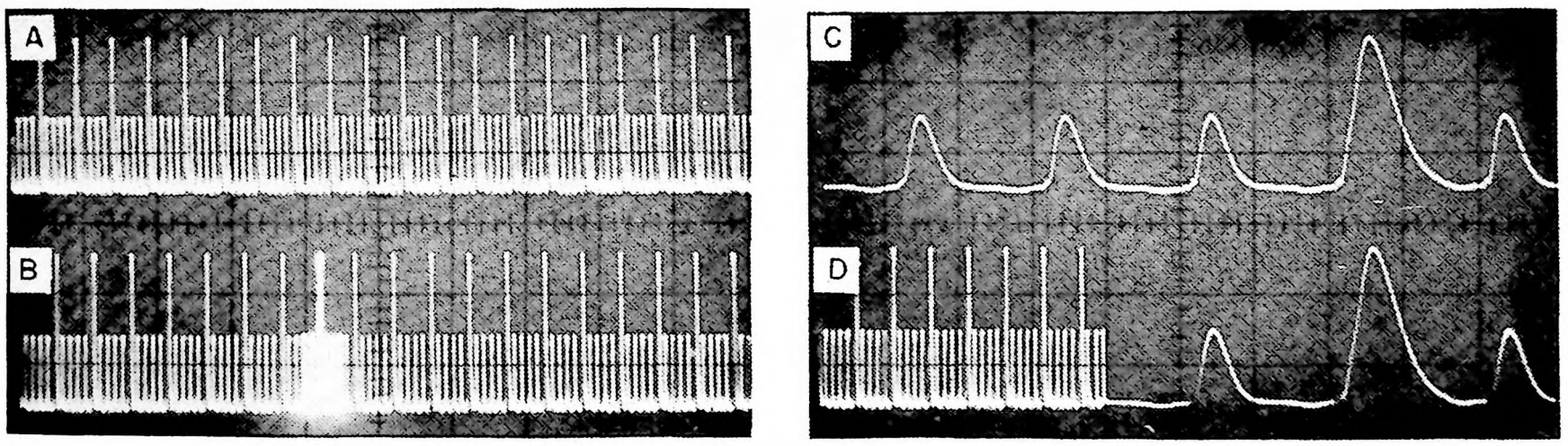


Figure 1-2. Waveforms illustrating sweep combinations using Model 1821A: (A) normal sweep; (B) intensified sweep (portion covered by delayed sweep is brightened); (C) delayed sweep (intensified portion of B is expanded to full 10 cm); (D) mixed sweep (faster delayed sweep drives right portion of display).

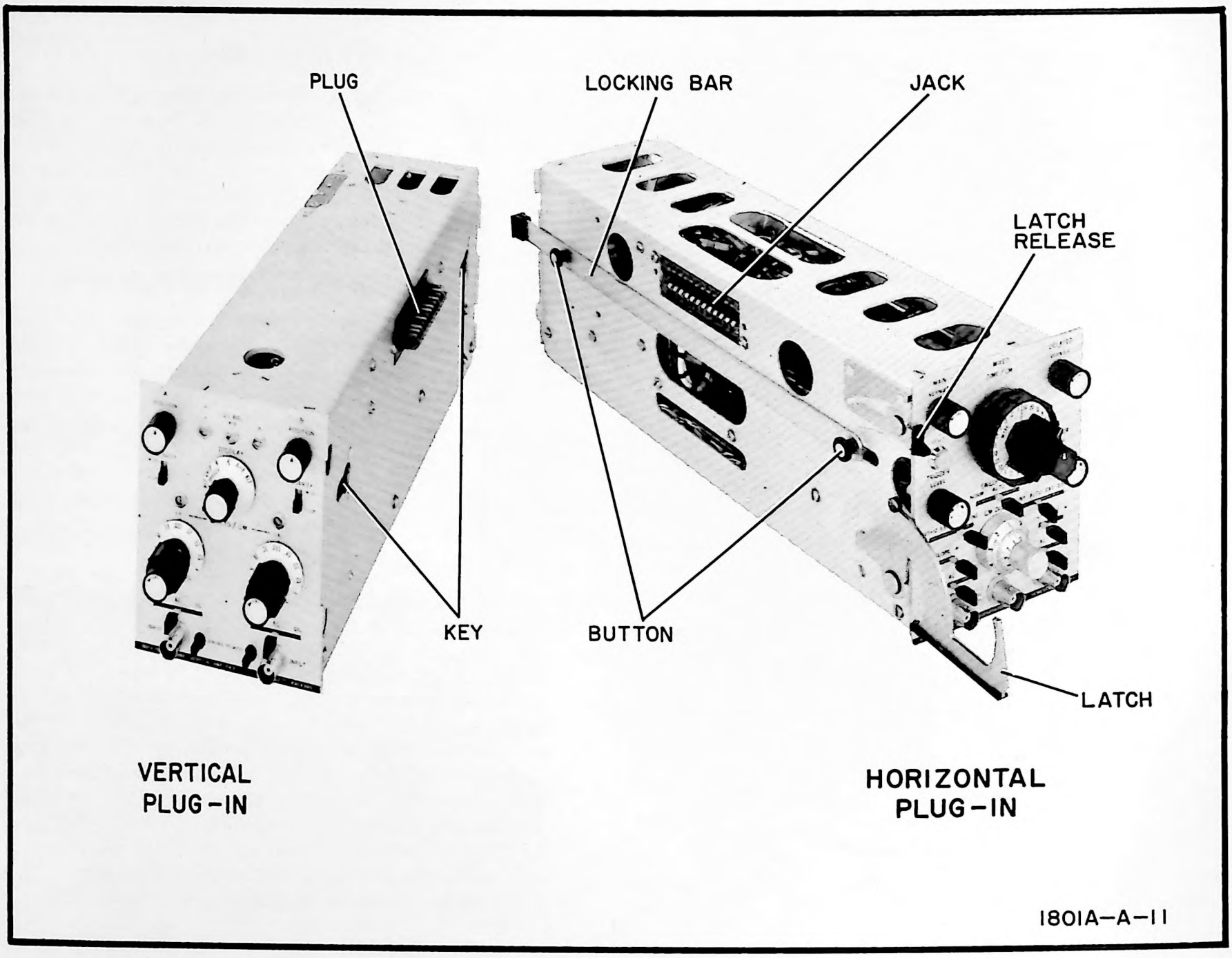


Figure 2-1. Plug-in Mating

SECTION II
INSTALLATION

2-1. INITIAL INSPECTION.

2-2. MECHANICAL CHECK. Check the shipping carton for damage immediately after receipt. If it is damaged, ask the carrier's agent to be present when the instrument is unpacked. Inspect the Model 1821A for physical damage such as bent or broken parts and dents or scrateches. If damage is found refer to Paragraph 2-4 for recommended claim procedure. If the Model 1821A appears undamaged, perform the electrical check (Paragraph 2-3). Retain the packaging material for possible future use.

2-3. ELECTRICAL CHECK. The performance check is given in paragraphs 5-5 through 5-22. This check will determine whether or not the instrument is still operating within its specifications as listed in Table 1-1. The initial performance and accuracy of this instrument are certified as stated on the inside front cover of this manual. If the Model 1821A does not operate as specified, refer to Paragraph 2-4 for the recommended claim procedure.

2-4. CLAIMS.

2-5. If physical damage is found or if the instrument is not within specifications when received, notify the carrier and the nearest Hewlett-Packard Sales/Service Office immediately. The Sales/Service Office will arrange for the repair or replacement of the instrument without waiting for a claim to be settled with the carrier.

2-6. The warranty statement for all Hewlett-Packard products is on the inside front cover of this manual. Contact the nearest Sales/Service Office for information about warranty claims.

2-7. REPACKAGING FOR SHIPMENT.

2-8. If the instrument is to be shipped to a Hewlett-Packard Sales/Service Office, attach a tag to it showing owner and owner's address, instrument's model number and eight digit serial number, and a description of service required.

2-9. The original shipping carton and packaging materials, except for the accordion-pleated pads, should be used for reshipment. If they are not available or reusable, the instrument should be repackaged with the following materials:

a. A double walled carton (refer to table 2-1 for test strength required).

b. Heavy paper or sheets of cardboard to protect all instrument surfaces (use a nonabrasive material such as polyurethane or a cushioned paper such as Kimpak around all projecting parts).

c. At least 4 inches of tightly packed, industry approved, shock absorbing material, such as extra firm polyurethane foam.

d. Heavy duty shipping tape to secure outside of carton.

Table 2-1. Shipping Carton Test Strengths

Gross Weight (lbs)	Carton Test Strength (lbs)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

2-10. PREPARATION FOR USE.

2-11. The Model 1821A and the vertical plug-in must be locked together before being inserted, as a unit, into the plug-in compartment of the Model 180A/AR (this procedure is explained below). Power for the Model 1821A is supplied by the Model 180A/AR Oscilloscope.

2-12. To insert plug-in into the Model 180A/AR, proceed as follows:

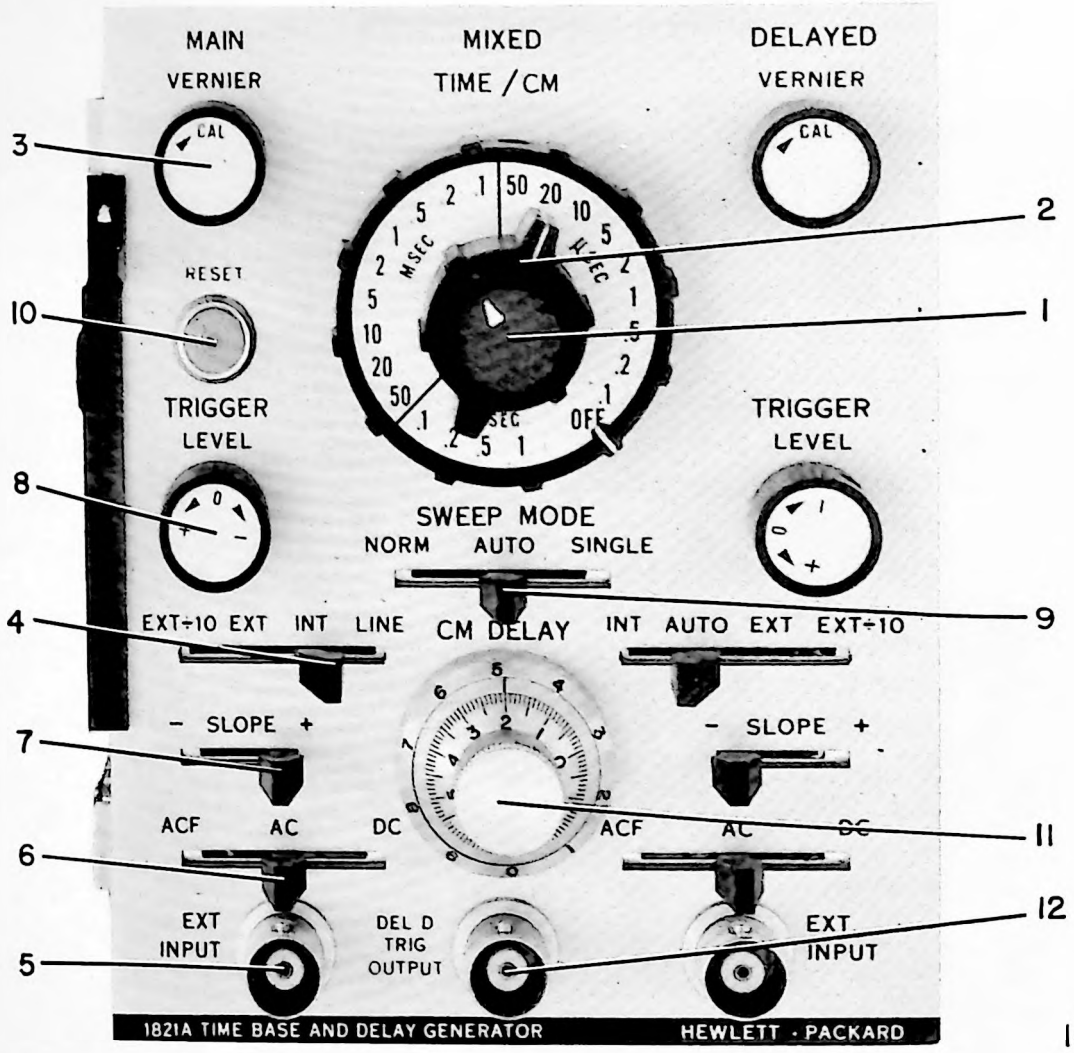
a. Move locking bar to rear (see Figure 2-1).

b. Fit vertical plug into horizontal jack and press plug-ins firmly together.

c. After insuring that front and rear panels are aligned, push locking bar forward.

d. Insert plug-ins into Model 180A/AR Oscilloscope.

e. Rotate plug-in latch upward and push toward panel to lock.



1. Sweep Display. Determines which sweep is displayed; main, mixed, or delayed.
2. TIME/CM (main). Selects main sweep speed.
3. VERNIER (main). Adjusts time/cm of main sweep between calibrated positions of TIME/CM.
4. Trigger Source (main). Selects source of signal that starts main sweep. For delay see Par. 3-12.
5. EXT INPUT (main). Connector for applying an external trigger.
6. Trigger Coupling (main). Selects type of trigger coupling.
7. SLOPE (main). Determines on which slope of trigger main sweep starts.
8. TRIGGER LEVEL (main). Selects point on trigger waveform that will start the main sweep.
9. SWEEP MODE (main). Selects type of main sweep operation.
10. RESET (main). Arms circuit (lamp lights) so that next trigger will start a single sweep.
11. CM DELAY. (delayed). Adjusts time between start of main sweep and arming of delayed sweep circuits.
12. DEL'D TRIG OUTPUT. (delayed). Connector for applying a positive trigger to external equipment. Trigger occurs when delayed sweep circuit is armed.

Figure 3-1. Controls and Connectors

SECTION III
OPERATION

3-1. GENERAL.

3-2. The Model 1821A produces two linear sweeps for use as time bases in the Model 180A/AR Oscilloscope. The delayed sweep circuit is armed by the main sweep after an adjustable delay period. Control settings determine whether the delayed sweep is automatically triggered immediately after the delay, or if it is triggered by the next input signal. Waveforms may be viewed on either time base alone, or on both time bases combined.

3-3. CONTROLS AND CONNECTORS.

3-4. Locations of controls and connectors are shown in Figure 3-1 along with a brief description of their functions. Controls that perform the same function for both main and delayed sweeps are explained for main sweep only. The following paragraphs explain some control functions in more detail.

3-5. SWEEP DISPLAY. The three positions of this switch are MAIN, MIXED, and DELAYED. The display obtained in each position is explained below.

a. MAIN. The vertical input signal is displayed on a time base as set by the main TIME/CM control. With the delayed TIME/CM switch set to OFF the entire main sweep display will be of normal intensity. Any other setting of the delayed TIME/CM control will cause the main sweep to be at a reduced intensity with an intensified section during the time the delayed sweep is produced.

b. MIXED. In this mode the first part of the vertical input signal is displayed on a time base set by main TIME/CM. The last part is displayed on a time base set by delayed TIME/CM. The delay between the start of the main sweep and the start of the delayed sweep is determined in part by CM DELAY.

c. DELAYED. The vertical input signal is displayed on a time base that is set by the delayed TIME/CM control. The delayed sweep, however, cannot be triggered before the delay, set by CM DELAY, has elapsed. This delay is not visible as it was in mixed operation.

3-6. TIME/CM. The main and delayed TIME/CM switches control the time that it takes the main and delayed sweeps to move ten centimeters. The switches are concentric and interlocked so that the delayed sweep will always be faster than the main sweep. The main TIME/CM switch can select sweep speeds from 1 sec/cm to .1 μsec/cm. The delayed TIME/CM can select sweep speeds from 50 msec/cm to .1 μsec/cm. The selected main and delayed sweep speeds may be increased five or ten times by positioning MAGNIFIER, on the Model 180A/AR, to X5 and X10 respectively. The delayed TIME/CM should be positioned to OFF to view a main sweep display of normal intensity.

3-7. VERNIER. The main and delayed VERNIER controls provide continuous adjustment of sweep times between the calibrated steps of their respective TIME/CM switches. When VERNIER is set to CAL (fully cw) sweep time can be read directly from its TIME/CM switch. As VERNIER is rotated ccw the selected sweep speed decreases. With VERNIER fully ccw the sweep speed is approximately 2.5 times as slow as the indicated speed.

3-8. SWEEP MODE. This lever switch determines the type of main sweep triggering. The AUTO position provides a baseline in the absence of a trigger. AUTO allows the main sweep to freerun at a rate determined by the main TIME/CM control. The freerunning rate is increased as the sweep speed is increased. A trigger signal will override the auto circuit if its frequency is 50 Hz or greater. NORMAL should be used if the trigger frequency is less than 50 Hz or if triggering is erratic. NORMAL, however, will not provide a baseline in the absence of a trigger. Selecting SINGLE allows the main sweep circuit to be triggered only once. The sweep circuit must be rearmed manually, by depressing RESET, to be triggered again.

3-9. CM DELAY. This control adjusts the delay between the start of the main sweep and the arming of the delayed sweep. The delay time is the product of the CM DELAY setting and the main TIME/CM setting.

3-10. The delayed sweep will start exactly at the end of the delay time only if the delayed Trigger Source switch is set to AUTO. All other positions of delayed Trigger Source will cause the delayed sweep to start on the first trigger after the delay time.

Note

A single CM DELAY reading has little meaning. Accurate time measurements can be made only by subtracting one reading from another.

3-11. TRIGGER SOURCE. The Main and Delayed Trigger Source switches determine the origin of the main and delayed triggers. When INT is selected, the main and delayed sweeps are triggered by the vertical deflection signal. When EXT or EXT ÷ 10 is selected, the sweeps are triggered by the signals applied to their EXT INPUT connectors. EXT ÷ 10 attenuates the external trigger and should be used when the trigger signal is greater than 10 v pk - pk.

3-12. Each switch has one position not common to the other. The LINE position on the main switch allows the main sweep to be triggered by the power line waveform. The AUTO position on the delayed switch causes the delayed sweep to start precisely at the end of the delay time set by CM DELAY. All other positions of the delayed switch will cause the delayed sweep to start on the first trigger after the delay time.

3-13. TRIGGER COUPLING. These switches determine the type of coupling for the main and delayed

triggers. Direct (DC) coupling is normally used for any trigger signal from DC to greater than 90 MHz. Capacitive (AC) coupling should be selected when it is desirable to block the dc level of the trigger signal. AC coupling however, will attenuate signals below 20 Hz. AC fast (ACF) attenuates signals below 15 kHz and is used, for instance, to eliminate 60 Hz ripple that might trigger the sweep.

3-14. SLOPE. The setting of this switch determines whether the sweep triggers on the positive going (+) or negative going (-) portion of the trigger signal. When delayed Trigger Source is set to AUTO the delayed SLOPE control does not function.

3-15. LEVEL. This control establishes the point on the trigger waveform that starts the sweep. This point is adjustable from -5 v to +5 v along the selected slope. With an external trigger and the Trigger Source switch in EXT÷ 10 the trigger point is adjustable from -50 v to +50 v along the selected slope. When the delayed Trigger Source switch is in AUTO, the delayed LEVEL control does not function. The main LEVEL control always can vary the trigger point for the main sweep.

3-16. TRIGGER SOURCE REQUIREMENTS.

3-17. Table 3-1 shows the trigger source requirements of the Model 1821A with various combinations of control settings. Figure 3-2 is used in conjunction with the table to determine the typical trigger amplitude necessary at frequencies up to 100 MHz.

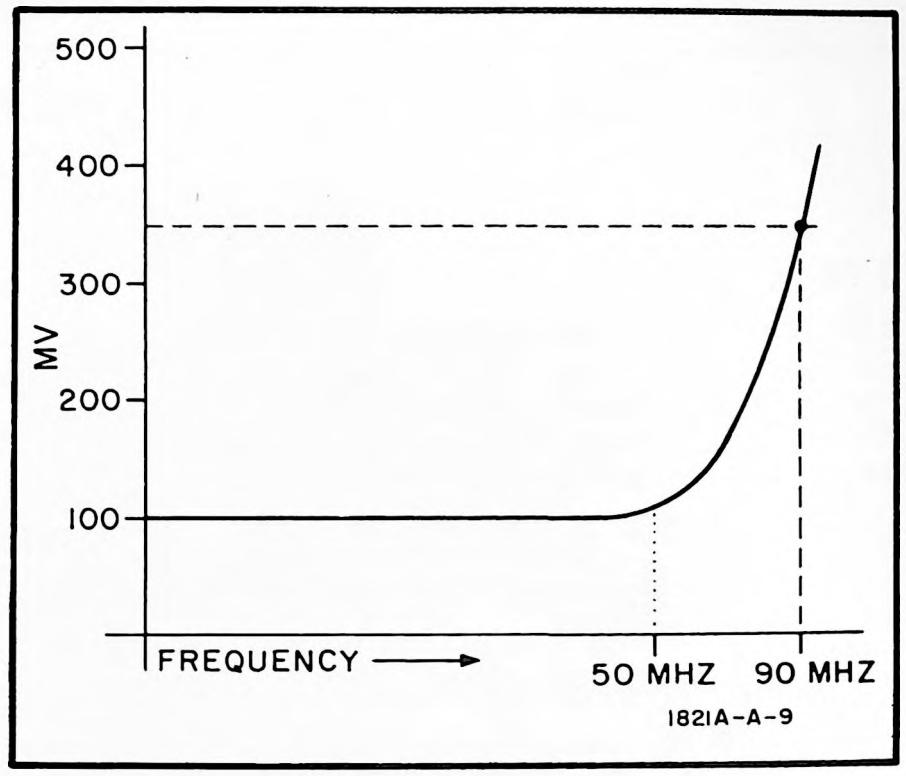


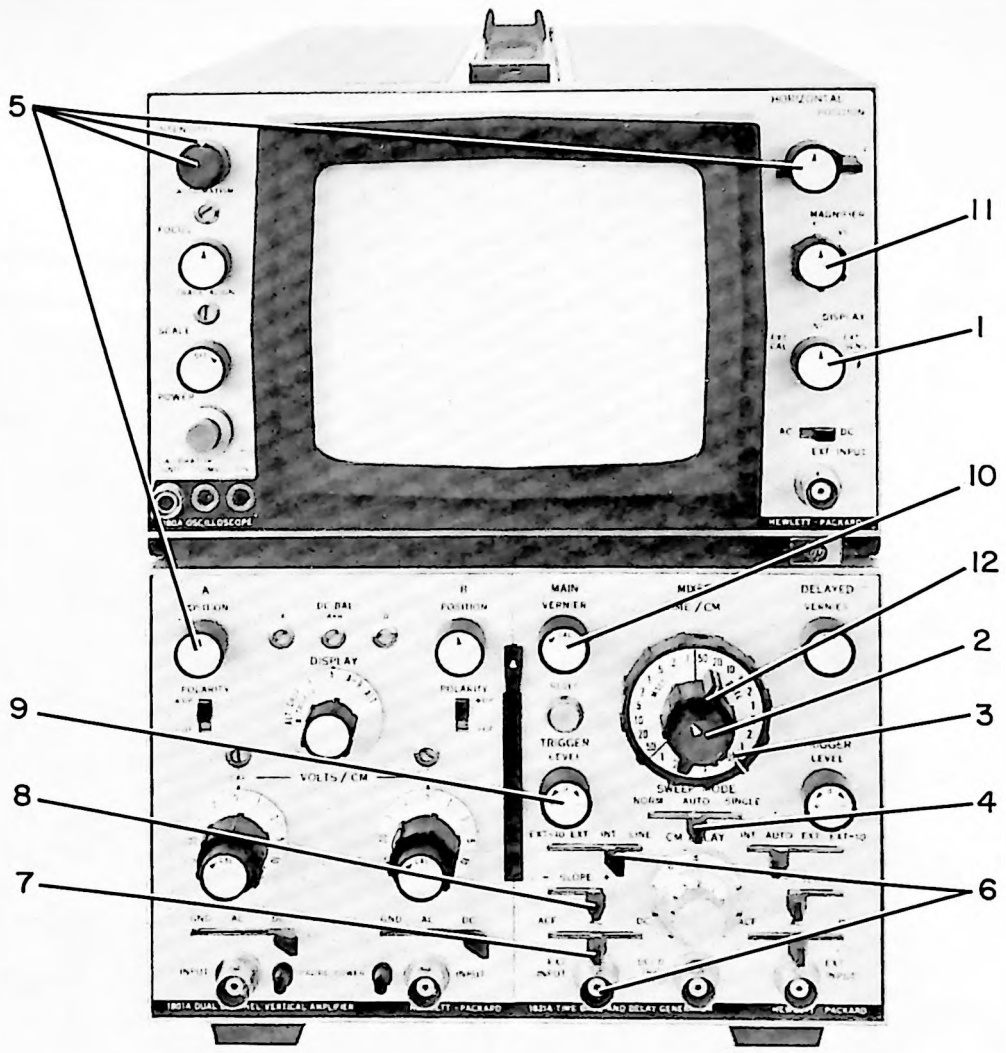
Figure 3-2. Trigger Amplitude Requirements

3-18. OPERATING INSTRUCTIONS.

3-19. Figure 3-3 through 3-7 give step-by-step operating instructions for the Model 1821A. These instructions are keyed to the photograph in each figure with index numbers. The preceding paragraphs contain additional information and should be read before using the operating instructions.

Table 3-1. Trigger Source Requirements

	SWEEP MODE	TRIGGER SOURCE	TRIGGER COUPLING	TRIGGER AMPLITUDE	LEVEL	SLOPE
MAIN	NORMAL	LINE	AC: 20 Hz to 90 MHz DC: dc to 90 MHz ACF: 15 kHz to 90 MHz	See Figure 3-2	Adjustable +5 v to -5 v	Selectable + or -
		INT				
		EXT				
		EXT÷ 10		10 times that shown on Figure 3-2	Adjustable +50 v to -50 v	
	AUTO	LINE	AC: 40 Hz to 90 MHz DC: 40 Hz to 90 MHz ACF: 15 kHz to 90 MHz	See Figure 3-2	Adjustable +5 v to -5 v	
		INT				
		EXT				
		EXT÷10		10 times that shown on Figure 3-2	Adjustable +50 v to -50 v	
	SINGLE	Single may be selected after setting up any display				
DELAYED		AUTO	No function	Automatically triggered at end of delay	No function	
		INT	AC: 20 Hz to 90 MHz DC: DC to 90 MHz ACF: Attenuates signals below 15 kHz	See Figure 3-2	Adjustable +5 v to -5 v	Selectable + or -
		EXT				
		EXT÷ 10		10 times that shown on Figure 3-2	Adjustable +50 v to -50 v	



Obtain a baseline as follows:

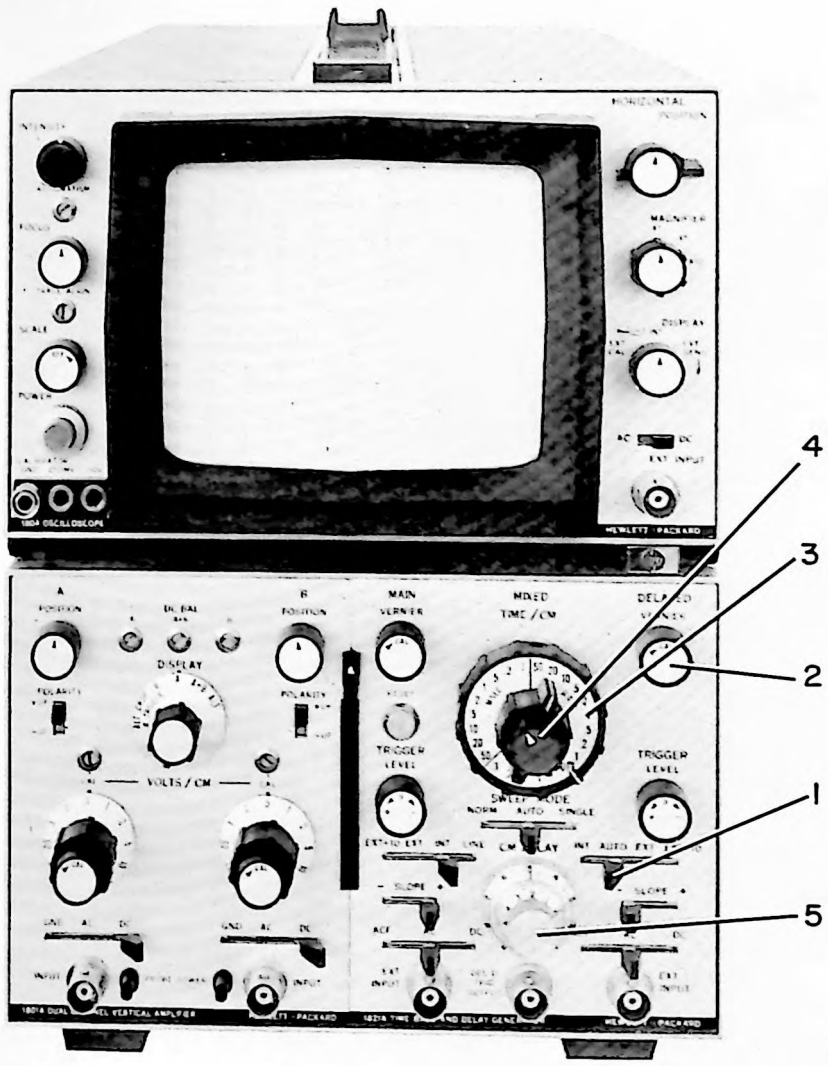
1. Set Horiz DISPLAY to INT.
2. Set Sweep Display to MAIN.
3. Position Delayed TIME/CM to OFF.
4. Set SWEEP MODE to AUTO.
5. Use FIND BEAM with INTENSITY and position controls, if necessary, to locate baseline.

Set controls of Vertical Plug-In as desired (refer to Vertical Plug-In Manual.)

Adjust Horizontal Display as follows:

6. Set Trigger Source as desired (if EXT or EXT ÷ 10 is selected connect trigger to EXT INPUT).
7. Select desired coupling.
8. Select desired slope.
9. Adjust LEVEL for desired trigger point. (If display is unstable, set SWEEP MODE to NORMAL and adjust LEVEL.)
10. Set main VERNIER to CAL.
11. Set MAGNIFIER to X1.
12. Set main TIME/CM as desired.

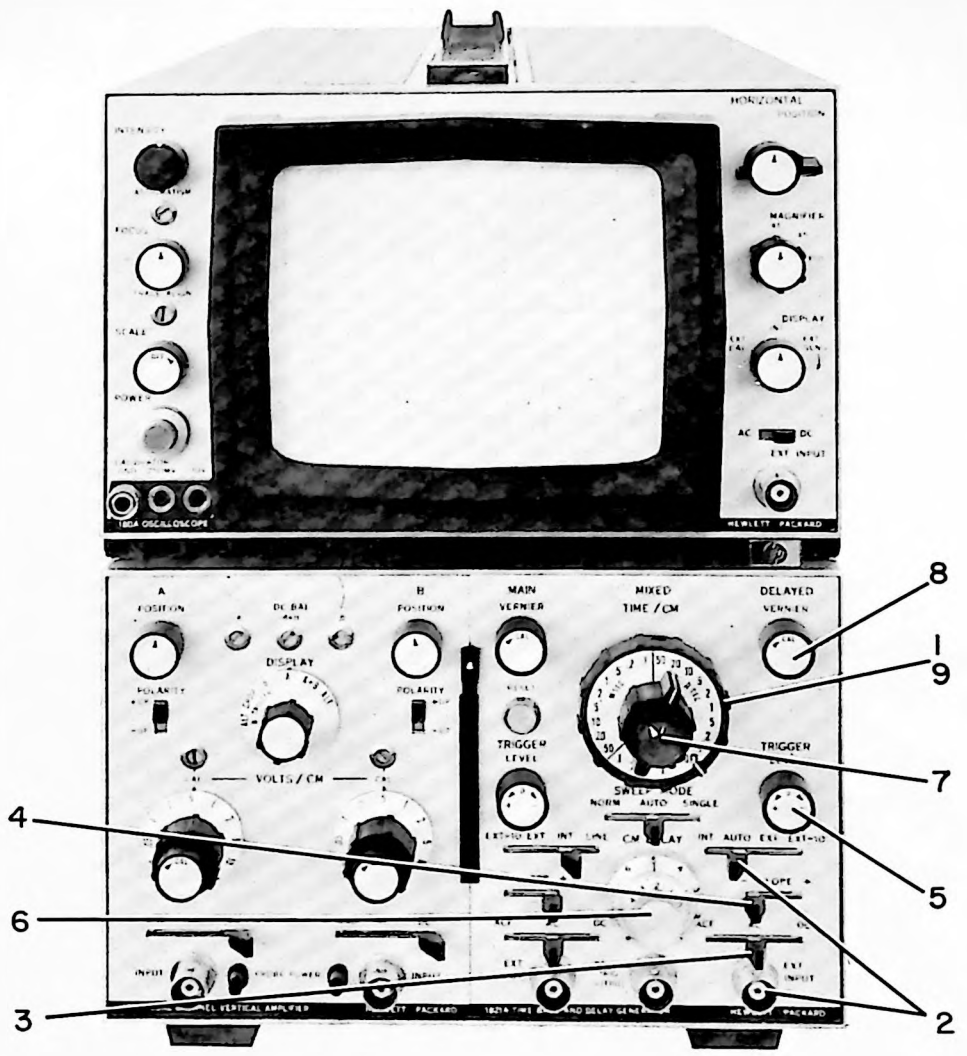
Figure 3-3. Main Sweep Operation



Set up main sweep as explained in Figure 3-3.

1. Set delayed Trigger Source to AUTO.
2. Rotate Delayed VERNIER fully cw to CAL.
3. Rotate the delayed TIME/CM ccw from OFF and set the delayed sweep time ten to one-hundred times faster than the main sweep time (if possible).
4. Set Sweep Display to MIXED.
5. Adjust CM DELAY until desired portion of waveform is displayed on delayed sweep.

Figure 3-4. Mixed Sweep Operation

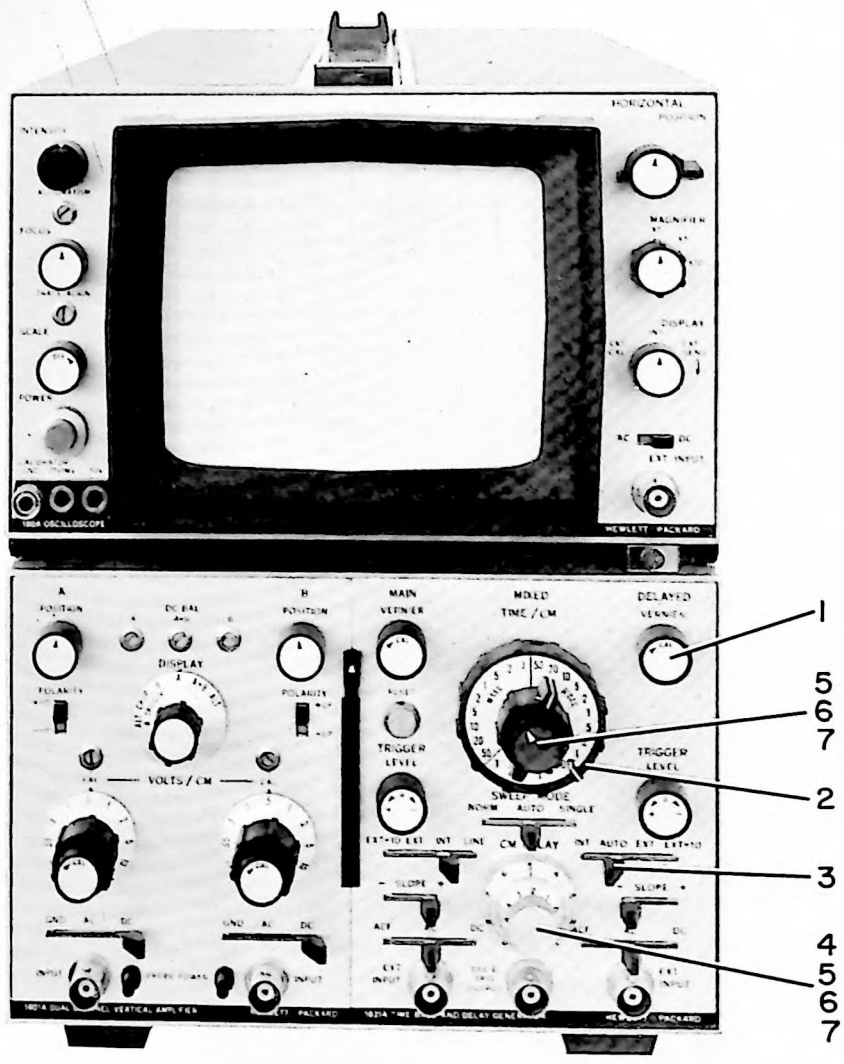


RISE TIME MEASUREMENTS

Set up main sweep as explained in Figure 3-3.

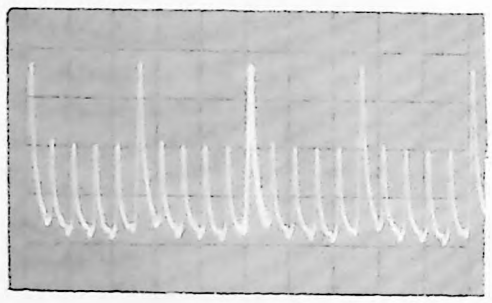
1. Rotate the delayed TIME/CM control ccw from OFF.
2. Set delayed Trigger Source to INT, EXT, or EXT ÷10 as desired. (If EXT or EXT ÷10 is selected connect trigger to EXT INPUT.)
3. Set delayed Trigger Coupling as desired.
4. Set delayed SLOPE as desired.
5. Adjust delayed LEVEL for an intensified display. (If intensified display does not appear, set CM DELAY to 1.)
6. Adjust CM DELAY to intensify desired signal.
7. Set Sweep Display to DELAYED and observe previously intensified portion of signal.
8. Set delayed VERNIER to CAL.
9. Set delayed TIME/CM as desired.

Figure 3-5. Rise Time Measurements

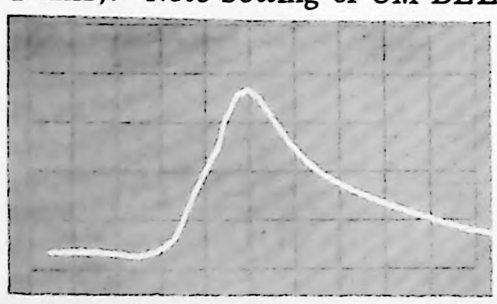


Set up main sweep as explained in Figure 3-2.

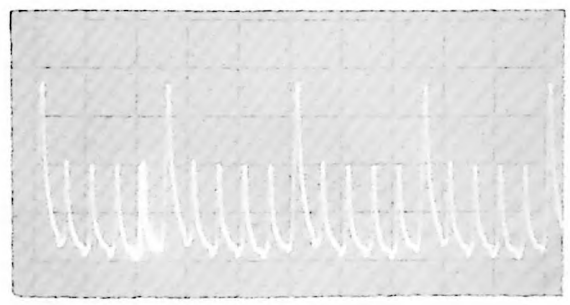
1. Set delayed VERNIER to CAL.
2. Turn the delayed sweep on by setting delayed TIME/CM ten to one-hundred times faster than main TIME/CM.
3. Set delayed Trigger Source to AUTO.
4. Adjust CM DELAY to intensify first point of interest, A, on waveform.



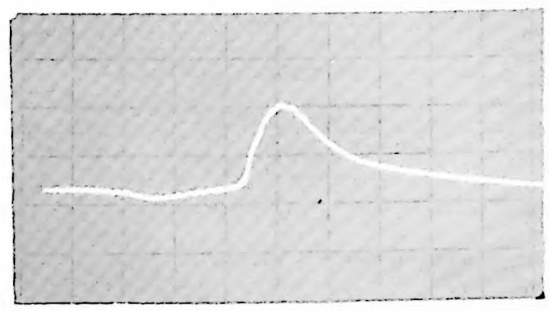
5. Set Sweep Display to DELAYED and adjust CM DELAY to set A on a reference (typically the Y axis). Note setting of CM DELAY.



6. Set Sweep Display to MAIN and adjust CM DELAY to intensify second point of interest, B.

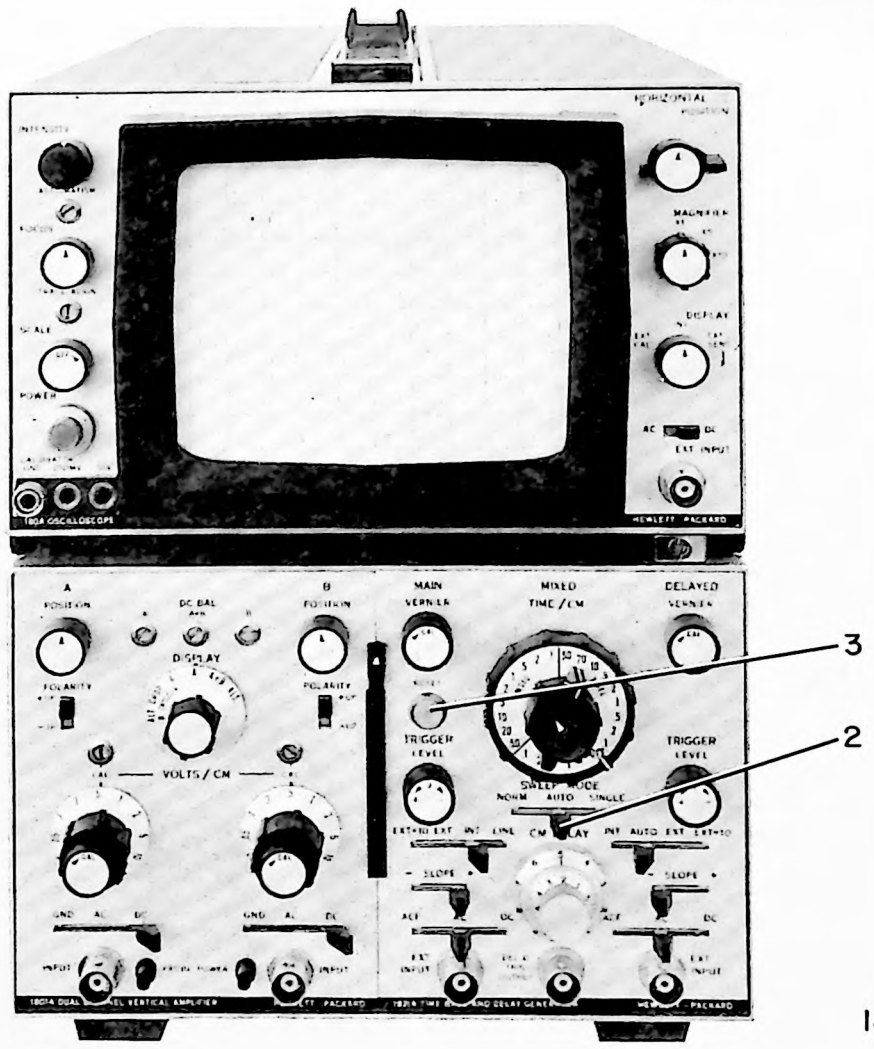


7. Set Sweep Display to DELAYED and adjust CM DELAY to set B on same reference line as A.



Calculate the difference between the setting of CM DELAY in steps #5 and #7. Multiply the main TIME/CM setting by this difference to obtain the time between the two points A and B.

Figure 3-6. Time Differential Measurements



1. Perform instructions given in any previous operating procedure.
2. Set SWEEP MODE to SINGLE.
3. Press RESET to ARM SWEEP.
4. The RESET indicator will light, indicating sweep is armed. The first trigger input will start the sweep. The RESET indicator will extinguish at the end of the sweep.

Figure 3-7. Single Sweep Operation

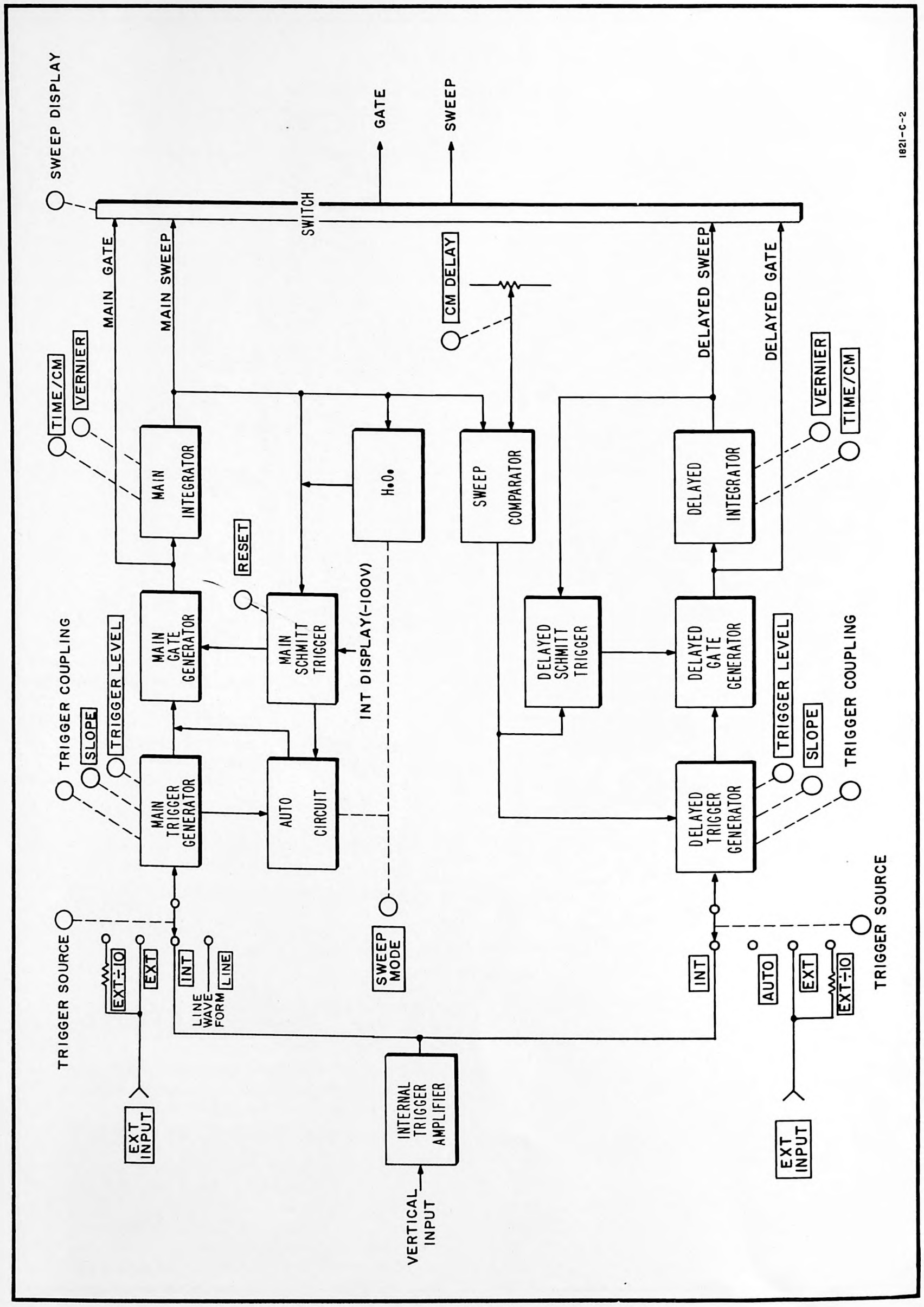


Figure 4-1. Model 1821A Block Diagram

SECTION IV
PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. The Model 1821A Time Base and Delay Generator, a horizontal plug-in unit for the Model 180A/AR Oscilloscope, generates two linear sweeps: main and delayed. Either sweep (or a combination of both) may be selected by front panel controls. The selected sweep is applied to the oscilloscope to drive the horizontal deflection plates of the CRT. Outputs are provided (on rear panel of oscilloscope) for horizontal MAIN and DELAYED SWEEP OUTPUTS and MAIN and DELAYED GATE OUTPUTS. A DEL'D TRIG OUTPUT is included on the Model 1821A front panel.

4-3. External signals, internal signals (originating in the vertical plug-in), or line frequency signals from the oscilloscope can be used to trigger the Model 1821A. All necessary operating voltages are provided by the oscilloscope. Figure 4-1 is an over-all block diagram showing the principal circuits and their relationships.

4-4. OVER-ALL DESCRIPTION.

4-5. MAIN SWEEP GENERATOR.

4-6. NORMAL OPERATION. The main sweep circuit consists primarily of a trigger generator, gate generator, and integrator. The circuitry can be triggered, or set for free run. When triggered operation is employed, the required trigger signal is derived from one of four sources: LINE frequency signals; INT signals from the vertical plug-in, amplified by the internal trigger amplifier; EXT; and EXT $\div$ 10 signals.

4-7. The selected trigger signal is applied to the main trigger generator. Here, by use of a tunnel diode, a fast rising pulse is generated and amplified. The SLOPE switch selects triggering from either the positive-going or negative-going slope of the incoming trigger signal. The TRIGGER LEVEL control selects the triggering point on the incoming signal, and the coupling switch permits selection of input coupling. The output of the main trigger generator is a fast rising negative pulse used to trigger the main gate generator.

4-8. The main gate generator, when triggered, produces a negative rectangular pulse. This gate is sent to the oscilloscope unblanking amplifier circuitry to unblank the trace during the time of display and is also coupled to the oscilloscope rear panel as the MAIN GATE OUTPUT. The sweep gate is also sent to the main integrator circuit.

4-9. The integrator circuit is normally clamped such that its output is a constant dc voltage. The negative gate signal unclamps the integrator which starts generating the sweep signal, a positive-going sawtooth. This sweep, coupled through the Sweep Display switch, is sent to the horizontal amplifier in the oscilloscope to drive the horizontal deflection plates. The sweep speed is determined by the position of the MAIN TIME/CM selector.

4-10. The main sweep signal is also sent to the main Schmitt trigger, causing it to change state. When the Schmitt trigger changes state, its output "flips" the main Gate Generator to a "no-trigger" or "off" condition. The output of the gate circuit terminates at this time; hence, the integrator ceases to produce a sweep, and its output returns to a constant dc.

4-11. The hold-off circuit, after a brief delay, produces a negative voltage that is felt on the Schmitt trigger. This causes the Schmitt to change state again, placing the main gate generator to a "pre-trigger" or "on" condition. Once the main gate generator is reset, it is then ready for another trigger signal.

4-12. SINGLE SWEEP OPERATION. When the SWEEP MODE switch is set to the SINGLE position, the negative reset voltage from the hold-off circuit is disabled, and the RESET push button must be pressed to return the main gate generator to its "pre-trigger" condition.

4-13. AUTO (free run) OPERATION. In the AUTO mode, operating voltages are supplied to the auto circuit, placing it in operation. If any incoming trigger is received while in AUTO, a portion of negative spike generated by the main trigger generator is sent to the auto circuit making it inoperative. This allows the sweep circuits to operate from the incoming trigger as previously described. However, if the trigger frequency drops below approximately 40 Hz, is removed completely, or if main TRIGGER LEVEL control is maladjusted, the circuitry will free run.

4-14. The auto circuit provides enough additional current to "turn on" the main gate generator, in turn producing the negative gate signal. This gate, sent to the main integrator, causes the main sweep to be generated. When the sweep rises to sufficient amplitude to cause the Schmitt trigger to change state (no-trigger condition) the auto circuit also turns off. After the hold-off time delay, the Schmitt trigger changes state again returning the main gate generator to a pre-trigger condition. The circuitry waits for an incoming trigger. If none arrives, or if trigger frequency is less than 40 Hz, or if main TRIGGER LEVEL control is maladjusted, the auto circuit once again provides current to turn on the main gate generator and the aforementioned cycle will repeat.

4-15. DELAYED SWEEP CIRCUIT.

4-16. The delayed sweep circuitry consists basically of the delayed trigger generator, delayed gate generator, and delayed integrator. Delayed sweep operation is similar to main sweep operation; however, there are 3 basic differences: the delayed circuitry cannot free run, does not have line frequency triggering and does not have a hold-off circuit for resetting the gate generator.

4-17. The sweep comparator determines when the delayed sweep should start by comparing the main sweep to some dc voltage determined by the CM DELAY control. When the positive-going sweep equals the dc voltage, the comparator generates a positive delayed trigger pulse. This pulse is sent to a front panel connector as the DEL'D TRIG OUTPUT, (not shown in Figure 4-1) and to the delayed Schmitt trigger, causing it to change state. This action places the delayed gate generator in a pre-trigger condition. In delayed AUTO mode, the positive pulse from the comparator also acts as the incoming trigger, triggering the delayed circuitry. In all other modes, either an external or an internal trigger is required for triggering.

4-18. When the delayed trigger generator is triggered, it produces a fast-rising negative pulse that triggers the delayed gate generator. The gate generator in turn generates a negative rectangular pulse, the delayed gate. The delayed gate is sent to the oscilloscope rear panel as the DELAYED GATE OUTPUT, and is also fed to the delayed integrator.

4-19. The integrator produces a linear, positive sawtooth that is sent to the horizontal amplifier in the oscilloscope to drive the horizontal deflection plates, and to the oscilloscope rear panel as the DELAYED SWEEP OUTPUT. Slope of the delayed sweep is determined by the delayed TIME/CM switch setting.

4-20. When the delayed sweep reaches some predetermined positive level, it causes the delayed Schmitt trigger to change state, terminating the delayed gate and the delayed sweep. If the main sweep ends prior to the delayed sweep, the comparator output goes negative, causing the delayed Schmitt to change state, placing the delayed gate generator in a "no-trigger" condition. This action terminates the delayed gate and delayed sweep, assuring that the delayed sweep ends when the main sweep ends. Sometime after the conclusion of the delayed sweep signals, the delayed sweep circuitry is reset by the sweep comparator, and awaits the next incoming trigger signal.

4-21. SWEEP DISPLAY FUNCTIONS.

4-22. When the Sweep Display switch is set to MAIN, the main sweep is fed into the horizontal amplifier in the oscilloscope. Both the main and delayed gates are sent to the gate amplifier in the oscilloscope. In DELAYED, the delayed sweep and delayed gate are sent to the oscilloscope.

4-23. In MIXED, the main gate is fed into the gate amplifier in the oscilloscope. A diode is inserted in the sweep signal path so that the larger of the two sweeps is fed to the horizontal amplifier. When the delayed sweep passes the main sweep, it pulls the main sweep up with it and, therefore, terminates both sweeps.

Table 5-1. Required Test Equipment

Recommended Instrument		Required Characteristics	Required for	Par Ref.
Type	Model			
Constant Amplitude Signal Generator	Tektronix Type 191A	50 kHz - 90 MHz @ 1 v pk-pk	Triggering	5-12
Oscillator	hp Model 200CD	40 Hz - 100 kHz @ 5 v pk-pk	Trigger Point and Slope Sweep Length	5-13, 5-31, 5-32
Time Mark Generator	Tektronix Type 180	10 MHz - 1 sec @ 3 v pk-pk	Sweep Times and Verniers; Delay Time Accuracy; Delay Time Linearity; Jitter; Sweep Times; Sweep Comparator	5-14 thru 5-20 5-33 thru 5-35
Oscilloscope	hp Model 140A w/1402A and 1420A	Sensitivity 0.1 v/cm sweep speed 50 nsec/cm	Delayed Trigger Output	5-21
DC Voltmeter	hp Model 412A	1 mv	Main Output Level; Delayed Output	5-29, 5-30
10:1 Divider Probe	hp Model 10001A		Delayed Trigger Output	5-21

SECTION V
PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section provides the performance check (Paragraph 5-5) and the adjustment procedures (Paragraph 5-24) for the Model 1821A. Troubleshooting information, schematic diagrams, and component identification are in Section VIII.

5-3. TEST EQUIPMENT.

5-4. Test equipment required for maintaining and checking the performance of the Model 1821A is listed in Table 5-1. Test equipment having characteristics similar to those listed in the table may be used for the performance check and adjustments.

5-5. PERFORMANCE CHECK.

5-6. The performance check verifies whether or not the Model 1821A is operating within the specifications as stated in Table 1-1. This check may be used as part of an incoming quality control inspection, as a periodic operational check, or after repairs and/or adjustments have been made. Recently calibrated test equipment should be used when performing this check.

5-7. A Performance Check Record is included in this manual on Page 5-2a/5-2b. As the initial performance check is accomplished, the actual readings should be entered on the form. The form should then be removed from the manual and filed in a safe place, so that readings taken at a later date can be compared with the original readings.

5-8. The performance check must be performed in the sequence given below. Do not attempt to start the procedure in mid-sequence, as succeeding steps are dependent on control settings and results of previous steps.

5-9. PRELIMINARY SET-UP.

5-10. Lock plug-ins together and install in Model 180A/AR Oscilloscope. Apply power and allow a 15 minute warm-up. Make certain the Model 180A/AR is calibrated.

5-11. INITIAL CONTROL SETTING.

a. Model 180A/AR Oscilloscope:

MAGNIFIER	X10
horizontal DISPLAY	INT

b. Vertical Amplifier:

vertical Display	A
A Polarity	+UP
A Vernier	CAL
A Volts/cm	0.1
A Coupling	AC

c. Model 1821A Time Base:

Sweep Display	MAIN
SWEEP MODE	AUTO
CM DELAY	1.00
main VERNIER	CAL
main Trigger Source	EXT
main SLOPE	+
main Trigger Coupling	AC
main TIME/CM	0.2 μSEC
delayed TIME/CM	OFF
delayed VERNIER	CAL
delayed Trigger Source	AUTO
delayed SLOPE	+
delayed Trigger Coupling	AC

5-12. TRIGGERING.

a. Connect a 50 MHz, 0.5 volt pk-pk signal from Constant Amplitude Signal Generator output to channel A Input, main EXT INPUT, and delayed EXT INPUT.

b. Obtain display with INTENSITY and position controls.

c. Adjust main TRIGGER LEVEL and note stable display.

d. Set Sweep Display to DELAYED and delayed TIME/CM to .1 μSEC. Note stable display.

e. Position delayed Trigger Source to EXT.

f. Adjust delayed TRIGGER LEVEL and note stable display.

g. Adjust Constant Amplitude Signal Generator for a 90 MHz, 1 volt pk-pk output signal.

h. Adjust delayed TRIGGER LEVEL and note stable display.

i. Position delayed Trigger Source to AUTO and note stable display.

j. Set Sweep Display to MAIN and delayed TIME/CM to OFF.

k. Adjust main TRIGGER LEVEL and note stable display.

5-13. TRIGGER POINT AND SLOPE.

a. Connect a 40 Hz, 5 volt pk-pk ac signal from Oscillator output to channel A Input, main EXT INPUT, and delayed EXT INPUT.

b. Set:

MAGNIFIER	X1
main TIME/CM	5 MSEC
Volts/cm	1

c. Adjust main TRIGGER LEVEL. Note that display is stable as trigger point moves smoothly along positive slope of waveform.

d. Set main SLOPE to —.

e. Adjust main TRIGGER LEVEL. Note that display is stable as trigger point moves smoothly along negative slope of waveform.

f. Set:

Sweep Display	DELAYED
delayed TIME/CM	2 MSEC
delayed Trigger Source	EXT

g. Adjust delayed TRIGGER LEVEL. Note that display is stable as trigger point moves smoothly along positive slope of waveform.

h. Set delayed SLOPE to — .

i. Adjust delayed TRIGGER LEVEL. Note that display is stable as trigger point moves smoothly along negative slope of waveform.

5-14. MAIN SWEEP TIME

a. Connect Time Mark Generator output to channel A Input.

b. Set: Sweep Display . . . . . MAIN
delayed TIME/CM . . . . . OFF
SWEEP MODE . . . . . NORMAL
main Trigger Source . . . . . INT
main SLOPE . . . . . +
A Volts/cm 0.5

c. Set Time Mark Generator and main TIME/CM switch according to Table 5-2. Adjust main TRIGGER LEVEL for display.

Table 5-2. Main Sweep Performance

Time Mark Generator	TIME/CM Setting	Time Mark to Check
10 MHz	.1 μSEC	11 (cycles)
1 μsec	1 μSEC	11
10 μsec	10 μSEC	11
100 μsec	.1 MSEC	11
1 msec	1 MSEC	11
10 msec	10 MSEC	11
10 msec	20 MSEC	21
1 sec	1 SEC	11

d. Adjust horizontal POSITION to align first marker (or reference point on sine wave) with left edge of graticule.

e. The 11th or 21st marker, or cycle, (according to Table 5-2), should be within 3 mm of right edge of graticule.

5-15. MAIN SWEEP VERNIER.

a. Set Time Mark Generator for 500 msec markers.

b. Set main TIME/CM to 50 MSEC and rotate main VERNIER fully ccw.

c. Two markers are displayed in less than 4 cm.

5-16. DELAYED SWEEP TIME.

a. Set: main VERNIER . . . . . CAL
main TIME/CM . . . . . 0.2 μSEC
Sweep Displayed . . . . . DELAYED
delayed Trigger Source . . . . . INT
delayed Slope . . . . . +

b. Set Time Mark Generator and Delayed TIME/CM according to Table 5-3. Adjust delayed TRIGGER LEVEL for display.

c. Adjust horizontal POSITION to align first marker (or reference point on sine wave) with left edge of graticule.

d. The 11th or 21st marker, or cycle, (according to Table 5-3) should be within 3 mm of right edge of graticule.

Table 5-3. Delayed Sweep Performance

Time Mark Generator	TIME/CM Setting	Time Mark to Check
10 MHz	.1 μSEC	11 (cycles)
1 μsec	1 μSEC	11
10 μsec	10 μSEC	11
100 μsec	.1 MSEC	11
1 msec	1 MSEC	11
1 msec	2 MSEC	21
500 msec	50 MSEC	11

5-17. DELAYED SWEEP VERNIER.

a. Set Time Mark Generator for 500 msec markers.

b. Rotate delayed VERNIER fully ccw.

c. Two markers are displayed in less than 4 cm.

5-18. DELAY TIME ACCURACY.

a. Set: Sweep Display . . . . . MAIN
main TIME/CM . . . . . 1 MSEC
delayed TIME/CM . . . . . 10 μSEC
delayed Trigger Source . . . . . AUTO

b. Set Time Mark Generator for 1 msec markers.

c. Adjust main TRIGGER LEVEL for display.

d. Adjust CM DELAY to intensify 2nd marker.

e. Position Sweep Display to DELAYED.

f. Adjust CM DELAY to align visible marker with start of sweep. Note CM DELAY setting.

g. Set Sweep Display to MAIN and adjust CM DELAY to intensify 10th marker.

h. Set Sweep Display to DELAYED.

i. Adjust CM DELAY to align visible marker with start of sweep. Note CM DELAY setting.

j. Difference between CM DELAY settings in steps d and f is 8.00 ±.08.

5-19. DELAY TIME LINEARITY.

a. Rotate CM DELAY cw from 0.00 and adjust to align first visible marker with start of sweep. Note CM DELAY setting.

b. Adjust CM DELAY to align 5th visible marker with start of sweep. Note CM DELAY setting.

c. Adjust CM DELAY to align 9th visible marker with start of sweep. Note CM DELAY setting.

d. Subtract the setting in step a from the setting in step c - Divide the difference by 2 - Add this result to the setting in step a - Subtract from this sum the setting of step b - Divide this result by 2.

e. Answer is 0 ±.02.

A = step a
B = step b
C = step c

$$\frac{A + \frac{C - A}{2} - B}{2} \leq \left| .02 \right|$$

5-20. JITTER.

a. Set delayed TIME/CM to 1 μSEC.

CUT ALONG DOTTED LINE

PERFORMANCE CHECK RECORD

Paragraph	Check	Min	Reading	Max
5-12	Triggering			
step c	main EXT	stable triggering @ 50 MHz	_____	
step d	delayed AUTO	stable triggering @ 50 MHz	_____	
step f	delayed EXT	stable triggering @ 50 MHz	_____	
step h	delayed EXT	stable triggering @ 90 MHz	_____	
step i	delayed AUTO	stable triggering @ 90 MHz	_____	
step k	main EXT	stable triggering @ 90 MHz	_____	
5-13	Trigger Point and Slope			
step c	main +	trigger on positive slope	_____	
step e	main -	trigger on negative slope	_____	
step g	delayed +	trigger on positive slope	_____	
step i	delayed -	trigger on negative slope	_____	
5-14	Main Sweep Time			
step e	.1 μsec	9.7 cm	_____	10.3 cm
"	1 μsec	9.7 cm	_____	10.3 cm
"	10 μsec	9.7 cm	_____	10.3 cm
"	.1 msec	9.7 cm	_____	10.3 cm
"	1 msec	9.7 cm	_____	10.3 cm
"	10 msec	9.7 cm	_____	10.3 cm
"	20 msec	9.7 cm	_____	10.3 cm
"	1 sec	9.7 cm	_____	10.3 cm
5-15 step c	Main Sweep Vernier		_____	4 cm
5-16	Delayed Sweep Time			
step d	.1 μsec	9.7 cm	_____	10.3 cm
"	1 μsec	9.7 cm	_____	10.3 cm
"	10 μsec	9.7 cm	_____	10.3 cm
"	.1 msec	9.7 cm	_____	10.3 cm
"	1 msec	9.7 cm	_____	10.3 cm
"	2 msec	9.7 cm	_____	10.3 cm
"	50 msec	9.7 cm	_____	10.3 cm
5-17 step c	Delayed Sweep Vernier		_____	4 cm
5-18 step j	Delayed Time Accuracy	7.92 cm	_____	8.08 cm
5-19 step e	Delayed Time Linearity	-0.02 cm	_____	+0.02 cm
5-20 step c	Jitter		_____	0.5 cm

PERFORMANCE CHECK RECORD

Paragraph	Check	Min	Reading	Max
5-21	Delayed Trigger Output			
step b	amplitude	1.5 v pk-pk	_____	
"	rise time		_____	50 nsec
5-22	Mixed Sweep			
step b		1st five cm brighter	_____	
5-23	Single Sweep			
step b	arming	lamp lighter	_____	
step d	sweep	one sweep and lamp extinguisher	_____	

CUT ALONG DOTTED LINE

b. Adjust CM DELAY to view the 9th visible marker.

c. Observe that horizontal jitter is less than 0.5 cm.

5-21. DELAYED TRIGGER OUTPUT.

a. Connect DEL'D TRIGGER OUTPUT through a 10:1 Divider Probe to the monitor Oscilloscope.

b. Observe a positive pulse greater than 1.5 volts in amplitude and with a rise time of less than 50 nsec.

5-22. MIXED SWEEP.

a. Set:

Sweep Display	MIXED
main TIME/CM	1 MSEC
CM DELAY	5.00

b. Observe that the first five centimeters of the display are brighter than the last five.

c. Disconnect Time Mark Generator.

5-23. SINGLE SWEEP.

a. Set:

Sweep Display	MAIN
SWEEP MODE	SINGLE
main TIME/CM	0.1 SEC
delayed TIME/CM	OFF

b. Depress RESET. RESET lamp lights.

c. Rotate main TRIGGER LEVEL.

d. Beam should sweep only once. RESET lamp extinguishes at end of sweep.

5-24. ADJUSTMENTS.

5-25. Procedures for making adjustments in the Model 1821A are given in Paragraphs 5-26 through 5-35. Required test equipment is listed in Table 5-1. Test equipment with similar characteristics may be substituted if necessary. Figure 8-1 shows the location of adjustments in the Model 1821A.

5-26. PRELIMINARY.

5-27. Lock plug-ins together and install in Model 180A/AR Oscilloscope. Apply power and allow a fifteen minute warm-up.

5-28. INITIAL CONTROL SETTINGS.

a. Model 180A/AR Oscilloscope:

MAGNIFIER	X1
horizontal DISPLAY	INT

b. Vertical Amplifier:

vertical DISPLAY	A
A Polarity	+UP
A Vernier	CAL
A Volts/cm	0.5
A Coupling	AC

c. Model 1821A Time Base:

Sweep Display	MAIN
SWEEP MODE	SINGLE
CM DELAY	1.00
main VERNIER	CAL
main Trigger Source	INT
main SLOPE	+
main Trigger Coupling	AC
main TIME/CM	0.5 MSEC
delayed TIME/CM	OFF
delayed VERNIER	CAL
delayed Trigger Source	INT
delayed SLOPE	+
delayed Trigger Coupling	AC

5-29. MAIN OUTPUT LEVEL.

a. Monitor TP205 (see Fig. 8-2) with DC Voltmeter.

b. Adjust R238 for 0 vdc.

5-30. DELAYED OUTPUT LEVEL.

a. Set delayed TIME/CM to .1 MSEC.

b. Monitor TP404 (see Fig. 8-2) with a DC Voltmeter and adjust R422 for 0 vdc.

5-31. MAIN SWEEP LENGTH

a. Set delayed TIME/CM to OFF and SWEEP MODE to AUTO.

b. Connect a 100 kHz, 3 v pk-pk, signal from Oscillator output to channel A Input.

c. Set main TRIGGER LEVEL for shortest horizontal display.

d. Adjust R251 for a horizontal display of 10 cm.

e. Adjust Horizontal POSITION to place right side of display on ninth graticule line and readjust R251 to increase display length 0.2 cm (this gives a total display length of 10.2 cm).

5-32. DELAYED SWEEP LENGTH.

a. Set Sweep Display to DELAYED and delayed TIME/CM to .5 MSEC.

b. Set delayed TRIGGER LEVEL for the shortest horizontal display.

c. Adjust R435 for a horizontal display of 10 cm.

d. Adjust horizontal POSITION to place right side of display on eighth graticule line and readjust R435 to increase display length 1.5 cm (this gives a total display length of 11.5 cm).

5-33. MAIN SWEEP TIME.

a. Set:

Sweep Display	MAIN
delayed TIME/CM	OFF
SWEEP MODE	NORMAL

b. Connect Time Mark Generator to channel A Input.

c. Set Time Mark Generator and main TIME/CM switch as indicated in Table 5-4. Adjust main TRIGGER LEVEL for display.

Table 5-4. Main Sweep Time

Time Mark Generator	TIME/CM	Time Mark to Adjust	Adjust
10 MHz	.1 μSEC	11 (cycles)	C510
1 μsec	1 μSEC	11	C508
5 μsec	5 μSEC	11	C506
50 μsec	50 μSEC	11	R516
500 μsec	.5 MSEC	11	R515
5 msec	5 MSEC	11	R514
50 msec	50 MSEC	11	R513

d. Adjust horizontal POSITION to align 1st marker with left edge of graticule.

e. Perform adjustment specified in Table 5-4 to align 11th marker with right edge of graticule.

5-34. DELAYED SWEEP TIME

a. Set Sweep Display to DELAYED and main TIME/CM to 0.2 μSEC.

b. Set Time Mark Generator and main TIME/CM as indicated on Table 5-5. Adjust delayed TRIGGER LEVEL for display.

c. Adjust horizontal POSITION to align 1st marker with left edge of graticule.

d. Perform adjustment specified in Table 5-5 to align 11th marker with right edge of graticule.

5-35. SWEEP COMPARATOR.

a. Set: main TIME/CM . . . . . 1 MSEC
delayed TIME/CM . . . . . 10 μSEC
delayed Trigger Source . . . . . AUTO
CM DELAY 0.00

Table 5-5. Delayed Sweep Time

Time Mark Generator	TIME/CM	Time Mark to Adjust	Adjust
10 MHz	.1 μSEC	11(cycles)	C532
1 μsec	1 μSEC	11	C530
5 μsec	5 μSEC	11	C528
50 μsec	50 μSEC	11	R539
500 μsec	.5 MSEC	11	R538
5 msec	5 MSEC	11	R537

b. Set Time Mark Generator for 1 msec markers.

c. Rotate CM DELAY cw from 0.00 until first marker appears. Set CM DELAY to 1.00 and adjust R473 to align leading edge of first marker with start of sweep.

d. Rotate CM DELAY cw from 0.00 until ninth marker appears. Set CM DELAY to 9.00 and adjust R469 to align leading edge of ninth marker with start of sweep.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replaceable parts for the instrument. Table 6-2 lists the parts in alpha-numerical order of their reference designations and provides the following information for each item:

a. hp Part Number.

b. Total quantity (TQ) used in instrument; given only first time a part number is listed.

c. Description of part; see Table 6-1 for list of reference designators and abbreviations.

d. Typical manufacturer of part in a five-digit code, except for Hewlett-Packard Company; see code list of manufacturers, Table 6-3, for name.

e. Manufacturer's part number.

6-3. Parts not identified by a reference designation are listed at the end of Table 6-2, under miscellaneous.

6-4. ORDERING INFORMATION.

6-5. To order a replacement part from the Hewlett-Packard Company, address the order or inquiry to the nearest Hewlett-Packard Sales/Service Office (list in rear of manual) and supply the following information:

a. hp Part Number of item(s).

b. Model number and eight-digit serial number of instrument.

6-6. To order a part not listed in the table, provide the following information:

a. Model number and eight-digit serial number of instrument.

b. Description of part including function and location.

6-7. To order a part from a manufacturer other than the Hewlett-Packard Company, provide the complete part description and the manufacturer's part number from the table.

Table 6-1. List of Reference Designators and Abbreviations

REFERENCE DESIGNATORS

A = assembly	E = misc electronic part	MP = mechanical part	TB = terminal board
B = motor	F = fuse	P = plug	TP = test point
C = capacitor	FL = filter	Q = transistor	V = vacuum tube, neon bulb, photocell, etc.
CP = coupling	J = jack	R = resistor	
CR = diode	K = relay	RT = thermistor	W = cable
DL = delay line	L = inductor	S = switch	X = socket
DS = device signaling (lamp)	M = meter	T = transformer	Y = crystal

ABBREVIATIONS

A = amperes	GE = germanium	N/C = normally closed	RMO = rack mount only
A.F.C = automatic frequency control	GL = glass	NE = neon	RMS = root-mean-square
AMPL = amplifier	GRD = ground(ed)	NI PL = nickel plate	
		N/O = normally open	S-B = slow-blow
B.F.O. = beat frequency oscillator	H = henries	NPO = negative positive zero (zero temperature coefficient)	SCR = screw
BE CU = beryllium copper	HEX = hexagonal		SE = selenium
BH = binder head	HG = mercury		SECT = section(s)
BP = bandpass	HR = hour(s)	NRFR = not recommended for field replacement	SEMICON = semiconductor
BRS = brass	hp = Hewlett-Packard		SI = silicon
BWO = backward wave oscillator	IF = intermediate freq	NSR = not separately replaceable	SIL = silver
	IMPG = impregnated		SL = slide
CCW = counter-clockwise	INCD = incandescent		SPL = special
CER = ceramic	INCL = include(s)	OBD = order by description	SST = stainless steel
CMO = cabinet mount only	INS = insulation(ed)	OH = oval head	SR = split ring
COEF = coefficient	INT = internal	OX = oxide	STL = steel
COM = common			
COMP = composition	K = kilo = 1000	P = peak	TA = tantalum
CONN = connector		PC = printed circuit	TD = time delay
CP = cadmium plate	LIN = linear taper	PF = picofarads = 10^{-12} farads	TGL = toggle
CRT = cathode-ray tube	LK WASH = lock washer		TI = titanium
CW = clockwise	LOG = logarithmic taper	PH BRZ = phosphor bronze	TOL = tolerance
	LPF = low pass filter	PHL = Phillips	TRIM = trimmer
DEPC = deposited carbon		PIV = peak inverse voltage	TWT = traveling wave tube
DR = drive	M = milli = 10^{-3}	P/O = part of	
	MEG = meg = 10^{6}	POLY = polystyrene	U = micro = 10^{-6}
ELECT = electrolytic	METFLM = metal film	PORC = porcelain	
ENCAP = encapsulated	MFR = manufacturer	POS = position(s)	VAR = variable
EXT = external	MINAT = miniature	POT = potentiometer	VDCW = dc working volts
	MOM = momentary	PP = peak-to-peak	
F = farads	MTG = mounting	PT = point	W/ = with
FH = flat head	MY = "mylar"	RECT = rectifier	W = watts
FIL H = fillister head		RF = radio frequency	WW = wirewound
FXD = fixed	N = nano (10^{-9})	RH = round head	W/O = without

01194-10

Table 6-2. Replaceable Parts

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
A1	01821-66502		1	A: sweep control board	hp	
A2	01821-66501		1	A: sweep board	hp	
A3	01821-61901		1	A: sweep time switch	hp	
C101	0160-2241		1	C: fxd my 2.2 pf ±.25 pf 500vdcw	hp	
C102	0180-0155		15	C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C103	0140-0145		3	C: fxd mica 22 pf 5% 500vdcw	04062	RDM15C2205
C104	0180-0155			C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C105	0150-0024		2	C: fxd cer .02 µf -20% +80% 600vdcw	71590	DD203
C106	0150-0051		2	C: fxd cer 100 pf 600vdcw	84411	OBD
C109	0160-0161		5	C: fxd my .01 µf 10%	hp	
C110	0160-0161			C: fxd my .01 µf 10%	hp	
C111	0180-0155			C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C112	0150-0050		4	C: fxd cer 1000 pf 600vdcw	84411	Type E
C113	0150-0050			C: fxd cer 1000 pf 600vdcw	84411	Type E
C117	0160-0168		4	C: fxd my .1 µf 10%	hp	
C118	0140-0176		7	C: fxd mica 100 pf 2% 300vdcw	04062	RDM15F101G3C
C119	0140-0203		5	C: fxd mica 30 pf 5% 500vdcw	04062	RDM15E300J
C120	0180-0155			C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C121	0140-0176			C: fxd mica 100 pf 2% 300vdcw	04062	RDM15F101G3C
C122	0180-0155			C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C123	0180-0155			C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C201	0140-0176			C: fxd mica 100 pf 2% 300vdcw	04062	RDM15F101G3C
C202	0140-0145			C: fxd mica 22 pf 5% 500vdcw	04062	RDM15C220J
C203	0180-0155			C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C204	0150-0042		2	C: fxd ti 4.7 pf 5% 500vdcw	78488	Type GA
C205	0140-0176			C: fxd mica 100 pf 2% 300vdcw	04062	RDM15F101G3C
C206	0160-0161			C: fxd my .01 µf 10%	hp	
C207	0160-0168			C: fxd my 0.1 µf 10%	hp	
C208	0170-0040		1	C: fxd my .047 µf 10% 200vdcw	hp	
C209	0140-0220		1	C: fxd mica 200 pf 1% 300vdcw	04062	RDM15F201F3C
C210	0160-2012		1	C: fxd mica 330 pf 5% 500vdcw	hp	
C213	0160-0162		15	C: fxd my .022 µf 10%	hp	
C214	0180-0155			C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C215	0160-0162			C: fxd my .022 µf 10%	hp	
C216	0160-0162			C: fxd my .022 µf 10%	hp	
C217	0140-0203			C: fxd mica 30 pf 5% 500vdcw	04062	RDM15E300J
C218	0140-0156		2	C: fxd mica 1500 pf 2% 300vdcw	04062	RDM19F152G3C
C219	0140-0215		3	C: fxd mica 80 pf 2% 300vdcw	04062	RDM15E800G3C
C220	0160-0162			C: fxd my .022 µf 10%	hp	
C301	0160-2239		1	C: fxd my 1.8 pf ±.25 pf 500vdcw	hp	
C302	0150-0024			C: fxd cer .02 µf -20% +80% 600vdcw	71590	DD203
C303	0150-0051			C: fxd cer 100 pf 600vdcw	84411	OBD
C307	0160-0161			C: fxd my .01 µf 10%	hp	
C308	0180-0155			C: fxd ta 2.2 µf 20% 20vdcw	56289	150D225X0020AZ
C309	0160-0161			C: fxd my .01 µf 10%	hp	
C310	0160-0162			C: fxd my .022 µf 10%	hp	
C311	0150-0050			C: fxd cer 1000 pf 600vdcw	84411	Type E

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
C312	0150-0050			C: fxd cer 1000 pf 600vdcw	84411	Type E
C316	0160-0168			C: fxd my . 1 μf 10%	hp	
C317	0140-0176			C: fxd mica 100 pf 2% 300vdcw	04062	RDM15F101G3C
C318	0140-0203			C: fxd mica 30 pf 5% 500vdcw	04062	RDM15E300J
C319	0180-0155			C: fxd ta 2.2 μf 20% 20vdcw	56289	150D225X0020AZ
C320	0180-0155			C: fxd ta 2.2 μf 20% 20vdcw	56289	150D225X0020AZ
C324	0160-0162			C: fxd my . 022 μf 10%	hp	
C325	0160-0162			C: fxd my . 022 μf 10%	hp	
C326	0160-0162			C: fxd my . 022 μf 10%	hp	
C327	0180-0082		2	C: fxd ta elect 30 μf -15% +20% 20vdcw	10411	MTA-30-20
C328	0180-0082			C: fxd ta elect 30 μf -15% +20% 20vdcw	10411	MTA-30-20
C401	0140-0176			C: fxd mica 100 pf 2% 300vdcw	04062	RDM15F101G3C
C402	0140-0145			C: fxd mica 22 pf 5% 500vdcw	04062	RDM15C220J
C403	0160-0162			C: fxd my . 022 μf 10%	hp	
C404	0160-0162			C: fxd my . 022 μf 10%	hp	
C405	0160-0162			C: fxd my . 022 μf 10%	hp	
C406	0140-0203			C: fxd mica 30 pf 5% 500vdcw	04062	RDM15E300J
C407	0140-0156			C: fxd mica 1500 pf 2% 300vdcw	04062	RDM19F152G3C
C408	0140-0190		1	C: fxd mica 39 pf 5% 300vdcw	04062	RDM15E390J3C
C409	0160-0162			C: fxd my . 022 μf 10%	hp	
C413	0140-0203			C: fxd mica 30 pf 5% 500vdcw	04062	RDM15E300J
C414	0140-0214		1	C: fxd mica 60 pf 5% 300vdcw	04062	RDM15E600J3C
C415	0160-0162			C: fxd my . 022 μf 10%	hp	
C416	0150-0042			C: fxd ti 4.7 pf 5% 500vdcw	78448	Type GA
C417	0140-0176			C: fxd mica 100 pf 2% 300vdcw	04062	RDM15F101G3C
C418	0150-0055		1	C: fxd ti 10 pf 5% 500vdcw	78488	Type GA
C419	0160-0162			C: fxd my . 022 μf 10%	hp	
C420	0180-0155			C: fxd ta 2.2 μf 20% 20vdcw	56289	150D225X0020AZ
C421	0180-0155			C: fxd ta 2.2 μf 20% 20vdcw	56289	150D225X0020AZ
C422	0140-0145			C: fxd mica 22 pf 5% 500vdcw	04062	RDM15C220J
C423	0160-0168			C: fxd my . 1 μf 10%	hp	
C424	0160-0162			C: fxd my . 022 μf 10%	hp	
C425	0180-0341		1	C: fxd elect 25 μf -10% +75% 12vdcw	56289	30D256G012BB4
C426	0180-0216		1	C: fxd ta elect 12 μf 10% 35vdcw	56289	150D126X9035R2
C501	0160-2433		1	C: fxd poly 1 μf 5% 100vdcw	01281	863 T (OBD)
C502	0160-2432		2	C: fxd poly . 1 μf 5% 100vdcw	01281	863 T (OBD)
C503	0160-2431		2	C: fxd poly . 01 μf 5% 100vdcw	01281	863 T (OBD)
C504	0160-2430		2	C: fxd poly . 001 μf 5% 100vdcw	01281	863 T (OBD)
C505	0140-0215			C: fxd mica 80 pf 2% 300vdcw	04062	RDM15E800G3C
C506	0121-0061		4	C: var cer 5.5-18 pf 300vdcw	hp	
C507	0160-0334		2	C: fxd my 43 pf ±.5 pf 10%	hp	
C508	0121-0061			C: var cer 5.5-18 pf 300vdcw	hp	
C509	0160-2264		1	C: fxd cer 20 pf 5% 500vdcw	72982	301-NPO-20 pf 5%
C510	0121-0060		2	C: var cer 2-8 pf	hp	

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
C514	0180-0155			C: fxd ta 2.2 μf 20% 20vdcw	56289	150D225X0020AZ
C515	0180-0218			C: fxd elect .15 μf 10% 35vdcw	56289	150D154X9035A2
C516	0170-0024		1	C: fxd my .022 μf 20% 200vdcw	hp	
C517	0160-0299		1	C: fxd my 1800 pf 10% 200vdcw	hp	
C518	0150-0072		1	C: fxd cer 200 pf 5% 500vdcw	56289	40C81A2
C519	0150-0073		1	C: fxd cer 100 pf 10% 500vdcw	56289	40C200A2
C520	0150-0078		1	C: fxd cer 56 pf 10% 1000vdcw	56289	40C130A2
C524	0160-2432			C: fxd poly .1 μf 5% 100vdcw	01281	863 T (OBD)
C525	0160-2431			C: fxd poly .01 μf 5% 100vdcw	01281	863 T (OBD)
C526	0160-2430			C: fxd poly .001 μf 5% 100vdcw	01281	863 T (OBD)
C527	0140-0215			C: fxd mica 80 pf 2% 300vdcw	04062	RDM15E800G3C
C528	0121-0061			C: var cer 5.5-18 pf 300vdcw	hp	
C529	0160-0334			C: fxd my 43 pf ±.5 pf 10%	hp	
C530	0121-0061			C: var cer 5.5-18 pf 300vdcw	hp	
C531	0160-2263		1	C: fxd cer 18 pf 5% 500vdcw	72982	301-NPO-18pf 5%
C532	0121-0060			C: var cer 2-8 pf	hp	
C601	0180-0155			C: fxd ta 2.2 μf 20% 20vdcw	56289	150D225X0020AZ
CR101	1901-0040		34	CR: si	hp	
CR102	1901-0040			CR: si	hp	
CR103	1901-0096		6	CR: si	hp	
CR104	1910-0016		12	CR: ge	hp	
CR105	1910-0016			CR: ge	hp	
CR106	1912-0004		2	CR: ge tunnel 5 ma	hp	
CR107	1901-0040			CR: si	hp	
CR108	1901-0040			CR: si	hp	
CR109	1901-0040			CR: si	hp	
CR110	1901-0040			CR: si	hp	
CR114	1901-0040			CR: si	hp	
CR115	1901-0040			CR: si	hp	
CR116	1901-0040			CR: si	hp	
CR117	1901-0040			CR: si	hp	
CR201	1912-0006		2	CR: ge tunnel 10 ma	hp	
CR202	1910-0016			CR: ge	hp	
CR203	1901-0040			CR: si	hp	
CR204	1901-0040			CR: si	hp	
CR205	1910-0016			CR: ge	hp	
CR206	1910-0016			CR: ge	hp	
CR210	1901-0040			CR: si	hp	
CR211	1901-0439		2	CR: si	hp	
CR212	1901-0096			CR: si	hp	
CR213	1901-0040			CR: si	hp	
CR214	1901-0040			CR: si	hp	
CR215	1901-0040			CR: si	hp	
CR216	1901-0040			CR: si	hp	
CR217	1901-0040			CR: si	hp	
CR218	1901-0040			CR: si	hp	
CR219	1901-0040			CR: si	hp	

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
CR301	1901-0096			CR: si	hp	
CR302	1910-0016			CR: ge	hp	
CR303	1910-0016			CR: ge	hp	
CR304	1912-0004			CR: ge tunnel 5 ma	hp	
CR305	1901-0040			CR: si	hp	
CR306	1901-0040			CR: si	hp	
CR307	1901-0040			CR: si	hp	
CR308	1901-0040			CR: si	hp	
CR309	1901-0096			CR: si	hp	
CR401	1912-0006			CR: ge tunnel 10 ma	hp	
CR402	1910-0016			CR: ge	hp	
CR403	1901-0040			CR: si	hp	
CR404	1901-0040			CR: si	hp	
CR405	1910-0016			CR: ge	hp	
CR406	1910-0016			CR: ge	hp	
CR410	1901-0040			CR: si	hp	
CR411	1901-0439			CR: si	hp	
CR412	1901-0040			CR: si	hp	
CR413	1901-0040			CR: si	hp	
CR414	1901-0096			CR: si	hp	
CR415	1901-0040			CR: si	hp	
CR416	1901-0040			CR: si	hp	
CR420	1910-0016			CR: ge	hp	
CR421	1910-0016			CR: ge	hp	
CR422	1901-0040			CR: si	hp	
CR423	1912-0007		1	CR: tunnel	hp	
CR424	1901-0040			CR: si	hp	
CR425	1901-0040			CR: si	hp	
CR501	1901-0096			CR: si	hp	
DS201				NSR: p/o S201		
J1	1251-0054		1	J: female 24 pin	hp	
J101	1250-0083		3	J: BNC female	hp	
J301	1250-0083			J: BNC female	hp	
J401	1250-0083			J: BNC female	hp	
L102	9140-0047		8	L: fxd 20 μh	99848	H51074020
L103	9140-0047			L: fxd 20 μh	99848	H51074020
L104	9170-0029		5	L: bead ferrite	02114	56-590-65/4A
L107	9140-0047			L: fxd 20 μh	99848	H51074020
L108	9170-0029			L: bead ferrite	02114	56-590-65/4A
L109	9140-0088		2	L: fxd 0.33 μh	95265	NBJ33-P
L110	9140-0047			L: fxd 20 μh	99848	H51074020

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
L201	9140-0047			L: fxd 20 μh	99848	H51074020
L202	9140-0115		3	L: fxd 22 μh	99800	2150-32
L301	9170-0029			L: bead ferrite	02114	56-590-65/4A
L302	9140-0047			L: fxd 20 μh	99848	H51074020
L303	9170-0029			L: bead ferrite	02114	56-590-65/4A
L304	9140-0088			L: fxd 0.33 μh	95265	NBJ33-P
L305	9140-0047			L: fxd 20 μh	99848	H51074020
L306	9140-0047			L: fxd 20 μh	99848	H51074020
L401	9170-0029			L: bead ferrite	02114	56-590-65/4A
L601	9140-0115			L: fxd 22 μh	99800	2150-32
L602	9140-0115			L: fxd 22 μh	99800	2150-32
P1	1251-0136		1	P: male 32 pin	02660	26-4100-32P
Q101	1854-0032		1	Q: si npn	01295	2N2221
Q102	1853-0010		1	Q: si pnp	hp	
Q103	1855-0020		5	Q: si fet	hp	
Q104	1854-0083		7	Q: si npn	hp	
Q105	1854-0083			Q: si npn	hp	
Q106	1853-0009		4	Q: si pnp	hp	
Q107	1850-0164		2	Q: ge pnp	hp	
Q108	1854-0009		2	Q: si npn	07263	2N709
Q109	1854-0019		9	Q: si npn	hp	
Q110	1850-0172		4	Q: ge pnp	01295	2N2996
Q111	1850-0172			Q: ge pnp	01295	2N2996
Q112	1854-0019			Q: si npn	hp	
Q201	1850-0172			Q: ge pnp	01295	2N2996
Q202	1854-0019			Q: si npn	hp	
Q203	1854-0022		5	Q: si npn	hp	
Q204	1854-0019			Q: si npn	hp	
Q205	1854-0019			Q: si npn	hp	
Q206	1853-0009			Q: si pnp	hp	
Q207	1855-0020			Q: si fet	hp	
Q208	1854-0083			Q: si npn	hp	
Q209	1854-0022			Q: si npn	hp	
Q210	1854-0083			Q: si npn	hp	
Q211	1854-0083			Q: si npn	hp	
Q301	1855-0020			Q: si fet	hp	
Q302	1854-0083			Q: si npn	hp	
Q303	1854-0083			Q: si npn	hp	
Q304	1853-0009			Q: si pnp	hp	
Q305	1850-0164			Q: ge pnp	hp	
Q306	1854-0009			Q: si npn	hp	
Q401	1850-0172			Q: ge pnp	01295	2N2996
Q402	1854-0019			Q: si npn	hp	
Q403	1854-0019			Q: si npn	hp	
Q404	1854-0019			Q: si npn	hp	
Q405	1853-0009			Q: si pnp	hp	

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
Q406	1855-0020			Q: si fet	hp	
Q407	1854-0083			Q: si npn	hp	
Q408	1854-0022			Q: si npn	hp	
Q409	1854-0019			Q: si npn	hp	
Q410	1850-0158		1	Q: ge pnp	01295	2N2635
Q411	1854-0022			Q: si npn	hp	
Q412	1855-0020			Q: si fet	hp	
Q413	1854-0022			Q: si npn	hp	
R101	0757-0467		1	R: fxd metflm 121k ohms 1% 1/8w	hp	
R102	0757-0290		3	R: fxd metflm 6.19k ohms 1% 1/8w	hp	
R103	0698-5472		2	R: fxd metflm 900k ohms 1% 1/8w	hp	
R104	0757-0466		4	R: fxd metflm 110k ohms 1% 1/8w	hp	
R105	0683-0275		4	R: fxd metflm 2.7 ohms 5% 1/4w	hp	
R106	0757-0438		10	R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R107	0757-0178		1	R: fxd metflm 100 ohms 1% 1/4w	hp	
R108	0757-0346		4	R: fxd metflm 10 ohms 1% 1/8w	hp	
R109	0757-0346			R: fxd metflm 10 ohms 1% 1/8w	hp	
R110	0757-0280		7	R: fxd metflm 1k ohms 1% 1/8w	hp	
R111	0683-0275			R: fxd metflm 2.7 ohms 5% 1/4w	hp	
R112	0757-0344		2	R: fxd metflm 1 megohm 1% 1/4w	hp	
R113	0757-0465		6	R: fxd metflm 100k ohms 1% 1/8w	hp	
R117	0757-0465			R: fxd metflm 100k ohms 1% 1/8w	hp	
R118	0757-0395		2	R: fxd metflm 56.2 ohms 1% 1/8w	hp	
R119	0757-0388		3	R: fxd metflm 30.1 ohms 1% 1/8w	hp	
R120	0812-0051		2	R: fxd ww 15k ohms 3% 3w	hp	
R121	2100-2001		2	R: var comp 5k ohms 10% 1/4w	hp	
R122	0757-0433		2	R: fxd metflm 3.32k ohms 1% 1/8w	hp	
R123	0757-0443		2	R: fxd metflm 11k ohms 1% 1/8w	hp	
R124	0757-0290			R: fxd metflm 6.19k ohms 1% 1/8w	hp	
R125	0757-0461		3	R: fxd metflm 68.1k ohms 1% 1/8w	hp	
R126	0811-1551		2	R: fxd ww 10k ohms 1% 3w	hp	
R130	0757-0346		3	R: fxd metflm 10 ohms 1% 1/8w	hp	
R131	0757-0392		3	R: fxd metflm 43.2 ohms 1% 1/8w	hp	
R132	0757-0401		13	R: fxd metflm 100 ohms 1% 1/8w	hp	
R133	0757-0845		6	R: fxd metflm 18.2k ohms 1% 1/2w	hp	
R134	0757-0421		2	R: fxd metflm 825 ohms 1% 1/8w	hp	
R135	0757-0414		6	R: fxd metflm 432 ohms 1% 1/8w	hp	
R136	0757-0436			R: fxd metflm 4.32k ohms 1% 1/8w	hp	
R137	0757-0427		6	R: fxd metflm 1.5k ohms 1% 1/8w	hp	
R138	0757-0282		3	R: fxd metflm 221 ohms 1% 1/8w	hp	
R139	0757-0413		4	R: fxd metflm 392 ohms 1% 1/8w	hp	
R140	0757-0442		3	R: fxd metflm 10k ohms 1% 1/8w	hp	
R141	0757-0419		4	R: fxd metflm 681 ohms 1% 1/8w	hp	
R145	0757-0200		1	R: fxd metflm 5.62k ohms 1% 1/8w	hp	
R146	0757-0481		3	R: fxd metflm 475k ohms 1% 1/8w	hp	
R147	0757-0414			R: fxd metflm 432 ohms 1% 1/8w	hp	
R148	0757-0416		4	R: fxd metflm 511 ohms 1% 1/8w	hp	
R149	0757-0283		1	R: fxd metflm 2k ohms 1% 1/8w	hp	

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
R150	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R151	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R152	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w	hp	
R153	0757-0461			R: fxd metflm 68.1k ohms 1% 1/8w	hp	
R154	0757-0419			R: fxd metflm 681 ohms 1% 1/8w	hp	
R155	0757-0444		1	R: fxd metflm 12.1k ohms 1% 1/8w	hp	
R156	0757-0273		3	R: fxd metflm 3.01k ohms 1% 1/8w	hp	
R201	0757-0284		2	R: fxd metflm 150 ohms 1% 1/8w	hp	
R202	0757-0413			R: fxd metflm 392 ohms 1% 1/8w	hp	
R203	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R204	0757-0274		2	R: fxd metflm 1.21k ohms 1% 1/8w	hp	
R205	0757-0280			R: fxd metflm 1k ohm 1% 1/8w	hp	
R206	0758-0073		2	R: fxd metflm 24k ohms 5% 1/2w	hp	
R207	0757-0441		2	R: fxd metflm 8.25k ohms 1% 1/8w	hp	
R208	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R209	0757-0414			R: fxd metflm 432 ohms 1% 1/8w	hp	
R210	0757-0414			R: fxd metflm 432 ohms 1% 1/8w	hp	
R211	0757-0431		1	R: fxd metflm 2.43k ohms 1% 1/8w	hp	
R215	0757-0452		1	R: fxd metflm 27.4k ohms 1% 1/8w	hp	
R216	0757-0471		2	R: fxd metflm 182k ohms 1% 1/8w		
R217	0757-0481			R: fxd metflm 475k ohms 1% 1/8w	hp	
R218	0757-0421			R: fxd metflm 825 ohms 1% 1/8w	hp	
R219	0757-0209		1	R: fxd metflm 274 ohms 1% 1/8w	hp	
R220	0757-0458		1	R: fxd metflm 51.1k ohms 1% 1/8w	hp	
R221	0757-0466			R: fxd metflm 110k ohms 1% 1/8w	hp	
R222	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R223	0757-0844		2	R: fxd metflm 16.2k ohms 1% 1/2w	hp	
R224	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R225	0757-0288		2	R: fxd metflm 9.09k ohms 1% 1/8w	hp	
R226	0757-0465			R: fxd metflm 100k ohms 1% 1/8w	hp	
R227	0757-0280			R: fxd metflm 1k ohm 1% 1/8w	hp	
R228	0757-0461			R: fxd metflm 68.1k ohms 1% 1/8w	hp	
R232	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R233	0757-0417		3	R: fxd metflm 562 ohms 1% 1/8w	hp	
R234	0683-2205		6	R: fxd comp 22 ohms 5% 1/4w	01121	CB 2205
R235	2100-2002		2	R: var car comp 50k ohms 30% 1/4w	hp	
R236	0757-0450		1	R: fxd metflm 22.1k ohms 1% 1/8w	hp	
R237	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w	hp	
R238	2100-0755		2	R: var ww 1k ohm 5%	hp	
R239	0757-0428		2	R: fxd metflm 1.62k ohms 1% 1/8w	hp	
R240	0757-0419			R: fxd metflm 681 ohms 1% 1/8w	hp	
R241	0757-0846		1	R: fxd metflm 22.1k ohms 1% 1/2w	hp	
R245	0683-2205			R: fxd comp 22 ohms 5% 1/4w	01121	CB 2205
R246	0757-0416			R: fxd metflm 511 ohms 1% 1/8w	hp	
R247	0757-0405		2	R: fxd metflm 162 ohms 1% 1/8w	hp	
R248	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w	hp	
R249	0757-0408		2	R: fxd metflm 243 ohms 1% 1/8w	hp	
R250	0757-0439		2	R: fxd metflm 6.81k ohms 1% 1/8w	hp	
R251	2100-1451		2	R: var ww 2.5k ohms 5% 1w	hp	
R252	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w	hp	
R253	0683-2205			R: fxd comp 22 ohms 5% 1/4w	01121	CB 2205

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
R254	0757-0481			R: fxd metflm 475k ohms 1% 1/8w	hp	
R255	0757-0471			R: fxd metflm 182k ohms 1% 1/8w	hp	
R256	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R257	0757-0461		2	R: fxd metflm 68.1k ohms 1% 1/8w	hp	
R301	0698-5472			R: fxd metflm 900k ohms 1% 1/8w	hp	
R302	0757-0466			R: fxd metflm 110k ohms 1% 1/8w	hp	
R303	0757-0344			R: fxd metflm 1.00 megohms 1% 1/4w	hp	
R304	0757-0465			R: fxd metflm 100k ohms 1% 1/8w	hp	
R307	0757-0465			R: fxd metflm 100k ohms 1% 1/8w	hp	
R308	0757-0395			R: fxd metflm 56.2 ohms 1% 1/8w	hp	
R309	0757-0346			R: fxd metflm 10 ohms 1% 1/8w	hp	
R310	0812-0051			R: fxd ww 15k ohms 3% 3w	hp	
R311	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R312	0811-1551			R: fxd ww 10k ohms 1% 3w	hp	
R313	2100-2001			R: var comp 5k ohms 10% 1/4w	hp	
R314	0757-0433			R: fxd metflm 3.32k ohms 1% 1/8w	hp	
R315	0757-0290			R: fxd metflm 6.19k ohms 1% 1/8w	hp	
R316	0757-0443			R: fxd metflm 11k ohms 1% 1/8w	hp	
R317	0757-0461			R: fxd metflm 68.1k ohms 1% 1/8w	hp	
R321	0757-0388			R: fxd metflm 30.1 ohms 1% 1/8w	hp	
R322	0757-0392			R: fxd metflm 43.2 ohms 1% 1/8w	hp	
R323	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R324	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w	hp	
R325	0757-0421		1	R: fxd metflm 825 ohms 1% 1/8w	hp	
R326	0757-0414			R: fxd metflm 432 ohms 1% 1/8w	hp	
R327	0757-0436			R: fxd metflm 4.32k ohms 1% 1/8w	hp	
R328	0757-0442			R: fxd metflm 10k ohms 1% 1/8w	hp	
R329	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w	hp	
R330	0757-0282			R: fxd metflm 221 ohms 1% 1/8w	hp	
R331	0757-0282			R: fxd metflm 221 ohms 1% 1/8w	hp	
R332	0757-0413			R: fxd metflm 392 ohms 1% 1/8w	hp	
R336	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R337	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R338	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R339	0683-0275			R: fxd comp 2.7 ohms 5% 1/4w	01121	CB 27G5
R340	0683-0275			R: fxd comp 2.7 ohms 5% 1/4w	01121	CB 27G5
R401	0757-0284			R: fxd metflm 150 ohms 1% 1/8w	hp	
R402	0757-0413			R: fxd metflm 392 ohms 1% 1/8w	hp	
R403	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R404	0757-0280			R: fxd metflm 1k ohm 1% 1/8w	hp	
R405	0757-0441			R: fxd metflm 8.25k ohms 1% 1/8w	hp	
R406	0758-0073			R: fxd metflm 24k ohms 5% 1/2w	hp	
R407	0757-0392			R: fxd metflm 43.2 ohms 1% 1/8w	hp	
R408	0757-0426		1	R: fxd metflm 1.3k ohms 1% 1/8w	hp	
R409	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R410	0757-0465			R: fxd metflm 100k ohms 1% 1/8w	hp	

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
R411	0757-0430		1	R: fxd metflm 2.21k ohms 1% 1/8w	hp	
R412	0757-0414			R: fxd metflm 432 ohms 1% 1/8w	hp	
R413	0757-0411		1	R: fxd metflm 332 ohms 1% 1/8w	hp	
R417	0757-0417			R: fxd metflm 562 ohms 1% 1/8w	hp	
R418	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R419	0683-2205			R: fxd comp 22 ohms 5% 1/4w	hp	
R420	2100-2002			R: var car comp 50k ohms 30% 1/4w w/switch	hp	
R421	0757-0450		1	R: fxd metflm 22.1k ohms 1% 1/8w	hp	
R422	2100-0755			R: var ww 1k ohm 5%	hp	
R423	0757-0428			R: fxd metflm 1.62k ohms 1% 1/8w	hp	
R424	0757-0419			R: fxd metflm 681 ohms 1% 1/8w	hp	
R425	0757-0846		1	R: fxd metflm 22.1k ohms 1% 1/2w	hp	
R429	0683-2205			R: fxd comp 22 ohms 5% 1/4w	01121	CB 27G5
R430	0757-0416			R: fxd metflm 511 ohms 1% 1/8w	hp	
R431	0757-0405			R: fxd metflm 162 ohms 1% 1/8w	hp	
R432	0757-0427			R: fxd metflm 1.5 ohms 1% 1/8w	hp	
R433	0757-0408			R: fxd metflm 243 ohms 1% 1/8w	hp	
R434	0757-0439		1	R: fxd metflm 6.81k ohms 1% 1/8w	hp	
R435	2100-1451			R: var ww 2.5k ohms 5% 1w	hp	
R436	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w	hp	
R437	0683-2205			R: fxd comp 22 ohms 5% 1/4w	hp	
R441	0757-0416			R: fxd metflm 511 ohms 1% 1/8w	hp	
R442	0757-0466			R: fxd metflm 110k ohms 1% 1/8w	hp	
R443	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R444	0757-0844			R: fxd metflm 16.2k ohms 1% 1/2w	hp	
R445	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R446	0757-0274			R: fxd metflm 1.21k ohms 1% 1/8w	hp	
R447	0757-0288		2	R: fxd metflm 9.09k ohms 1% 1/8w	hp	
R448	0757-0465			R: fxd metflm 100k ohms 1% 1/8w	hp	
R449	0683-1005		1	R: fxd comp 10 ohms 5% 1/4w	01121	CB 1005
R450	0757-0388		1	R: fxd metflm 30.1 ohms 1% 1/8w	hp	
R454	0757-0280			R: fxd metflm 1k ohm 1% 1/8w	hp	
R455	0757-0280			R: fxd metflm 1k ohm 1% 1/8w	hp	
R456	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w	hp	
R457	0757-0273			R: fxd metflm 3.01k ohms 1% 1/8w	hp	
R458	0757-0288			R: fxd metflm 9.09k ohms 1% 1/8w	hp	
R459	0757-0280			R: fxd metflm 1k ohm 1% 1/8w	hp	
R460	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R461	0757-0427			R: fxd metflm 1.5k ohms 1% 1/8w	hp	
R462	0757-0401			R: fxd metflm 100 ohms 1% 1/8w	hp	
R463	0757-0439			R: fxd metflm 6.81k ohms 1% 1/8w	hp	
R464	0757-0438			R: fxd metflm 5.11k ohms 1% 1/8w	hp	
R468	0757-0455		1	R: fxd metflm 36.5k ohms 1% 1/8w	hp	
R469	2100-0896		1	R: var ww 15k ohms 5% 1w	hp	
R470	0757-0451		1	R: fxd metflm 24.3k ohms 1% 1/8w	hp	
R471	2100-1443		1	R: var ww 50k ohms 3% 10 turn .1% lin 2w	hp	
R472	0757-0417			R: fxd metflm 562 ohms 1% 1/8w	hp	

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
R473	2100-0898		1	R: var ww 500 ohms 5%	hp	
R474	0757-0410		1	R: fxd metflm 301 ohms 1% 1/8w	hp	
R501	0698-5442		3	R: fxd metflm 6 megohms 1/2% 1/2w	hp	
R502	0698-5443		3	R: fxd metflm 9 megohms 1/2% 1/2w	hp	
R503	0698-5443			R: fxd metflm 9 megohms 1/2% 1/2w	hp	
R504	0698-5442			R: fxd metflm 6 megohms 1/2% 1/2w	hp	
R505	0698-5498		4	R: fxd metflm 1.5 megohms 0.1% 1/2w	hp	
R506	0698-5498			R: fxd metflm 1.5 megohms 0.1% 1/2w	hp	
R507	0698-5497		2	R: fxd metflm 600k ohms 0.1% 1/2w	hp	
R508	0698-5496		4	R: fxd metflm 255k ohms 0.1% 1/8w	hp	
R509	0698-5496			R: fxd metflm 255k ohms 0.1% 1/8w	hp	
R510	0698-5495		2	R: fxd metflm 102k ohms 0.1% 1/8w	hp	
R513	2100-0364		7	R: var ww 20k ohms 5% 1w	hp	
R514	2100-0364			R: var ww 20k ohms 5% 1w	hp	
R515	2100-0364			R: var ww 20k ohms 5% 1w	hp	
R516	2100-0364			R: var ww 20k ohms 5% 1w	hp	
R517	0757-0441		1	R: fxd metflm 8.25k ohms 1% 1/8w	hp	
R518	0757-0288			R: fxd metflm 9.09k ohms 1% 1/8w	hp	
R519	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w	hp	
R520	0698-5437		1	R: fxd metflm 12k ohms 1% 1/2w	hp	
R521	0757-0399		1	R: fxd metflm 82.5 ohms 1% 1/8w	hp	
R522	0757-0442			R: fxd metflm 10k ohms 1% 1/8w	hp	
R523	0757-0460		1	R: fxd metflm 61.9k ohms 1% 1/8w	hp	
R526	0698-5443			R: fxd metflm 9 megohms 1/2% 1/2w	hp	
R527	0698-5442			R: fxd metflm 6 megohms 1/2% 1/2w	hp	
R528	0698-5498			R: fxd metflm 1.5 megohms 1/10% 1/2w	hp	
R529	0698-5498			R: fxd metflm 1.5 megohms 1/10% 1/2w	hp	
R530	0698-5497			R: fxd metflm 600k ohms 1/10% 1/2w	hp	
R531	0698-5496			R: fxd metflm 255k ohms 1/10% 1/8w	hp	
R532	0698-5496			R: fxd metflm 255k ohms 1/10% 1/8w	hp	
R533	0698-5495			R: fxd metflm 102k ohms 1/10% 1/8w	hp	
R537	2100-0364			R: var ww 20k ohms 5% 1w	hp	
R538	2100-0364			R: var ww 20k ohms 5% 1w	hp	
R539	2100-0364			R: var ww 20k ohms 5% 1w	hp	
R540	0757-0436			R: fxd metflm 4.32k ohms 1% 1/8w	hp	
R541	0757-0437		1	R: fxd metflm 4.75k ohms 1% 1/8w	hp	
R542	0757-0845			R: fxd metflm 18.2k ohms 1% 1/2w	hp	
S101	3100-1346		2	S: lever 4 position	hp	
S102	3100-1341		1	S: lever 3 position	hp	
S103	3100-1342		2	S: lever 2 position	hp	
S104	3100-1343		1	S: lever 3 position	hp	
S201	3101-0944		1	S: push button (includes DS201)	81073	40YY2015-1
S301	3100-1346			S: lever 4 position	hp	
S302	3100-1347		1	S: lever 3 position	hp	
S303	3100-1342			S: lever 2 position	hp	

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
S501				NSR: p/o A3		
S502	3100-1349		1	S: sweep display	hp	
S503				NSR: p/o A3		
V201	2140-0018		1	V: neon 1/10w	24455	NE 2E1
VR101	1902-3150		2	VR: avalanche 9.1 v	hp	
VR102	1902-0052		1	VR: avalanche 6.8 v	hp	
VR201	1902-0214		2	VR: avalanche 56 v	hp	
VR301	1902-3150			VR: avalanche 9.1 v	hp	
VR401	1902-3288		2	VR: avalanche 30.9 v	hp	
VR402	1902-3288			VR: avalanche 30.9 v	hp	
VR403	1902-0214			VR: avalanche 56 v	hp	
				MISCELLANEOUS		
	0370-0341		1	Knob: black	hp	
	0370-0342		1	Knob: black	hp	
	0380-0022		2	Spacer: #5 x 3/8 (P1)	76854	3457
	0380-0059		4	Stand-off: 1/4"	hp	
	0380-0144		9	Stand-off: 3/16"	hp	
	0510-0942		2	Fastener: captive	46384	AS440-2
	1140-0036		1	Dial: 10 turn	hp	
	5040-0452		7	Knob: lever	hp	
	01801-01206		4	Bracket angle	hp	
	01821-00201		1	Panel: front	hp	
	01821-00203		1	Panel: rear	hp	
	01821-01201		1	Bracket: (A1)	hp	
	01821-01204		1	Bracket: plug (P1)	hp	
	01821-01205		1	Bracket: sweep dial	hp	
	01821-04001		1	Dial: sweep	hp	
	01821-04701		1	Support: right plug-in	hp	
	01821-21701		1	Bushing: push button	hp	
	01821-25701		1	Nut: bushing	hp	
	01821-60101		1	Chassis: right	hp	
				Consists of:		
	5000-0470		1	Bar: locking	hp	
	5020-0496		2	Guide: locking bar	hp	
	5020-0497		2	Button: locking bar	hp	
	5040-0456		1	Catch: plug-in lock	hp	
	5040-0457		1	Lock: plug-in	hp	
	01821-23101		1	Guide: plug-in lock	hp	
	01821-60201		1	Panel: sub	hp	
	01821-61601		1	Cable: #1	hp	
				Consists of:		
	01821-61612		1	Coax: (Q402 to CR410)	hp	
	01821-61613		1	Coax: (Q410 to C414)	hp	
	01821-61619		1	Coax: (Q402 to P1 pin 13)	hp	

Table 6-2. Replaceable Parts (Cont'd)

Ref Desig	hp Part No.	RS	TQ	Description (See Table 6-1.)	Mfr	Mfr Part No.
	01821-61602		1	Cable: #2	hp	
				Consists of:		
	01821-61604		1	Coax: (P1 pin 16 &32 to J1 pin 1 & 13)	hp	
	01821-61605		1	Coax: (R455 to J401)	hp	
	01821-61606		1	Coax: (P1 pin 6 to J1 pin 24)	hp	
	01821-61607		1	Coax: (J1 pin 16 to P1 pin 18)	hp	
	01821-61610		1	Coax: (J1 pin 14 to Q102)	hp	
	01821-61611		1	Coax: (R102 to S101)	hp	
	01821-61616		1	Coax: (R471 to Q412)	hp	
	01821-61617		1	Coax: (R434 to P1 pin 12)	hp	
	01821-61618		1	Coax: (R434 to S502)	hp	
	01821-61603		1	Cable: #3	hp	
				Consists of:		
	01821-61614		1	Coax: (S502 to R520)	hp	
	01821-61615		1	Coax: (R411 to S502)	hp	
	01821-61620		1	Coax: (R250 to P1 pin 11)	hp	
	01821-61621		1	Coax: (S502 to P1 pin 1)	hp	
	01821-61622		1	Coax: (Q202 to P1 pin 14)	hp	
	01821-61608		1	Cable: delayed sweep switch	hp	
	01821-61609		1	Cable: main sweep switch	hp	
	01821-61623		1	Coax: (R250 to S502)	hp	
	01821-67401		1	Knob: level	hp	
	01821-67402		1	Knob	hp	
	01821-67403		2	Knob	hp	

Table 6-3. Code List of Manufacturers

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00373	Garlock Inc., Electronics Products Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Chicago, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Somerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Chicago, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Fitron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Engineering Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., The	Bridgeport, Conn.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06475	Western Devices Inc.	Burbank, Calif.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Nuclear Corp. of America U.S. Semcor Div.	Phoenix, Arizona
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Eitel-McCullough Inc.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07966	Shockley Semi-Conductor Laboratories	Palo Alto, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09569	Mallory Battery Co. of Canada, Ltd	Toronto, Ontario, Canada
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Microwave Electronics Corp.	Palo Alto, Calif.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermalloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dublier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	So. Pasadena, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15818	Amelco Inc.	Mt. View, Calif.
15909	Daven Div. Thomas A. Edison Ind. McGraw-Edison Co.	Long Island City, N.Y.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Detroit, Ill.
16352	Computer Diode Corp.	Lodi, N.J.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokomo, Inc.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	Radio Industries	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	Bendix Corp., The Eclipse-Pioneer Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	New York, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio
24655	General Radio Co.	West Concord, Mass.
26365	Gries Reproducer Corp	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wiltek Mfg. Co.	Chicago, Ill.
66346	Revere Wollansak Div. Minn. Mining & Mfl. Co.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc	Union City, N.J.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema Plant, Hi-Q Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71753	A.O. Smith Corp., Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72354	John E. Fast Co., Div. Victoreen Instr. Co.	Chicago, Ill.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72765	Drake Mfg. Co.	Chicago, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. of North American Phillips Co., Inc.	Hicksville, N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc	Hartford, Conn.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75378	James Knights Co.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Div.	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	Bendix Corp., The Bendix Pacific Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.

From: FSC. Handbook Supplements
H4-1 Dated JULY 1965
H4-2 Dated NOV 1962

00015-41
Revised: November, 1965

Table 6-3. Code List of Manufacturers (Cont'd)

Code No.	Manufacturer	Address
81349	Military Specification	.....
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div., Industr. Tube Operations	Newton, Mass.
81483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc.	Watertown, Mass.
82042	Carter Parts Co.	Skokie, Ill.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Div.	Emporium, Pa.
82376	Astron Co.	East Newark, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals and Controls, Inc., Div. of Texas Instruments, Inc., Spencer Prods.	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Manufacturing Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83053	Western Washer Mfr. Co.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif.
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co., Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronis, Inc.	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.
85660	Koiled Kords, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86197	Clifton Precision Products	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	Seattle, Wash.
87930	Tower Mfg. Corp	Providence, R. I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89462	Waldes Kohinoor, Inc.	Cambridge, Mass.
89473	General Electric Distributing Corp.	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baler Co.	Chicago, Ill.
89665	United Transformer Co.	Chicago, Ill.
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Brothers', Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Philadelphia, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92607	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod. Inc., Semiconductor Div.	Woburn, Mass.
93369	Robbins and Myers, Inc.	New York, N.Y.
93410	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93788	Howard J. Smith Inc.	Port Monmouth, N. J.
93929	G. V. Controls	Livingston, N. J.
93983	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Components Div., Receiving Tube Operation	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div., California Street Plant	Newton, Mass.
94148	Scientific Radio Products, Inc.	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp., Electronics Div.	East Paterson, N.J.
94222	Southco Div. of S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod. Div. of Model Engineering and Mfg. Co.	Chicago, Ill.
94330	Wire Cloth Products Inc.	Chicago, Ill.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	New York, N.Y.
95264	Lerco Electronics, Inc.	Burbank, Calif.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordas Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Chicago, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co.	Chicago, Ill.
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	Hi-Q Division of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner Div. of Maguire Industries, Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic and Precision Mfg. Co.	Yonkers, N.Y.
97966	CBS Electronics, Div. of C.B.S., Inc.	Danvers, Mass.
97979	Reon Resistor Corp.	Yonkers, N.Y.
98141	Axel Brothers Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98405	Carad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co.	Mineola, N.Y.
98925	Clevite Transistor Prod. Div. of Clevite Corp.	Waltham, Mass.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99515	Marshall Industries, Electron Products Division	Pasadena, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Ill.
99957	Technology Instrument Corp of Calif.	Newbury Park, Calif.

THE FOLLOWING H-P VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

J0000	Winchester Electronics, Inc.	Santa Monica, Calif.
0000F	Malco Tool and Die	Los Angeles, Calif.
0000M	Western Coil Div. of Automatic Ind., Inc.	Redwood City, Calif.
0000P	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AA	British Radio Electronics Ltd.	Washington, D.C.
000AB	ETA	England
000AC	Indiana General Corp., Elect. Div.	Indiana
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Manufacturing Co.	San Jose 27, Calif.
000QQ	Cooltron	Oakland, Calif.
000SS	Control of Elgin Watch Co.	Burbank, Calif.
000WW	California Eastern Lab.	Burlingame, Calif.
000YY	S.K. Smith Co.	Los Angeles 45, Calif.

00144	ADC Products Inc. Subsidiary of Magnetic Controls Co.	Minneapolis, Minn.
01002	General Electric Co. Capacitor Dept.	Gainsville, Fla.
05397	Union Carbide Corp. Linde Division Kemet Dept.	Cleveland, Ohio
52983	Sanborn Co.	Waltham, Mass.
73586	Circle F Mfg. Co.	Trenton, N.J.
91886	Malco Mfg. Co., Inc.	Chicago, Ill.

From: FSC Handbook Supplements
H4-1 Dated DECEMBER 1964
H4-2 Dated MARCH 1962

00015-39
Revised: February, 1965

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. MANUAL CHANGES.

7-2. This manual applies directly to the standard Model 1821A Time Base and Delay Generator having a serial prefix 611-. The following paragraphs provide instructions for modifying this manual to cover older or newer instruments. Refer to the separate "Manual Changes" sheet supplied with this manual for Errata.

7-3. OLDER INSTRUMENTS.

7-4. Table 7-1 contains information on changes required to adapt this manual to an older instrument (lower serial prefix number). Check Table 7-1 for your instrument serial prefix and make the changes indicated. Note that these changes adapt the manual to cover a particular instrument as manufactured and therefore do not apply to an instrument subsequently modified in the field.

Table 7-1. Manual Changes

Serial Prefix	Make Changes
No backdating changes are required at the present time	

7-5. NEWER INSTRUMENTS.

7-6. As changes are made in the Model 1821A, newer instruments may have serial prefixes higher than 611-. The manual for these new instruments will be supplied with a "Manual Changes" sheet which contains all necessary updating information. If the serial prefix of your particular instrument is higher than the one listed at the front of this manual and no "Manual Changes" sheet has been provided, contact your nearest Hewlett-Packard Sales/Service Office.

7-7. OPTIONS.

7-8. Options for a hp instrument are standard modifications installed at the factory. At the present time, no options are offered for the Model 1821A.

7-9. SPECIAL INSTRUMENTS.

7-10. Modified versions (per customer's specifications) of any hp instruments are available on special order. The manual for these special instruments (having electrical modifications) will include a separate insert sheet that describes the modification and any special manual changes in addition to the "Manual Changes" sheet (if applicable). Contact the nearest hp Sales/Service Office if either of these sheets is missing from the manual of a special instrument. Be sure to refer to the instrument by its full specification name and number.

MANUAL CHANGES

MODEL 1821A

TIME BASE AND DELAY GENERATOR

Manual Serials Prefixed: 611-
Manual Printed: JULY 1966

Make all changes in this manual according to the Errata below. Also check the following table for your instrument serial prefix (3 digits) and/or serial number (8 digits) and make any listed change(s) in the manual.

Serial Prefix or Number	Make Manual Changes	Serial Prefix or Number	Make Manual Changes
630-	1, 2		
644-	1, 3		

ERRATA

Table 6-2,

△ C219: Change to hp Part No. 0140-0192; C: fxd, mica, 68 pf, 5%, 300vdcw; Mfr 04062; Mfr Part No. RDM15E680J3C (preferred replacement).

△ CR215 and CR413: Change to hp Part No. 1901-0050; CR: si; Mfr hp (preferred replacement).

△ S101: Change hp Part No. to 3100-1341.

△ S102, S302: Change hp Part No. to 3100-1346.

△ S301: Change hp Part No. to 3100-1347.

MISCELLANEOUS,

hp Part No. 01821-23101: Change to hp Part No. 01821-43101.

△ Page 8-5, Figure 8-3, Schematic,

Add: (3) (Test Point #3); Show at collector of Q107.

△ Page 8-7, Figure 8-4, Schematic,

C219: Change value to 68 pf.

△ Page 8-11, Figure 8-6, Schematic,

C404: Change value to .022 μf.

C425, C426, R471: Rearrange circuitry according to Figure 1.

△ Page 8-13, Figure 8-7, Schematic,

S502: Change to read: "Main Sweep from Junction of CR214/R250."

CHANGE 1

△ Page 3-1, Paragraph 3-13,

Add, following last sentence: AC slow (ACS) attenuates signals above approximately 30 kHz.

Table 6-2,

Add: L203 and L402; hp Part No. 9170-0029; L: bead; Mfr 02114; Mfr Part No. 56-590-65/4A.

R101: Change hp Part No. to 0757-0290; R: fxd, metflm, 6.19k ohms, 1%, 1/8w; Mfr hp.

△ Add: R114 and R305; hp Part No. 0757-0465; R: fxd, metflm, 100k ohms, 1%, 1/8w; Mfr hp.

S102 and S302: Change to hp Part No. 3100-1356; S: lever 4 position; Mfr hp.

Page 8-5, Figure 8-3, Schematic,

R101: Change value to 6190 ohms.

R101: Change input signal to 23 vac connected through P1 pin 31.

△ S102: Change according to Figure 2 (use designations not in parentheses) and add R114.

Page 8-7, Figure 8-4, Schematic,

Add: L203; L: bead; connect between Q207 gate and junction of CR211/S501.

Page 8-9, Figure 8-5, Schematic,

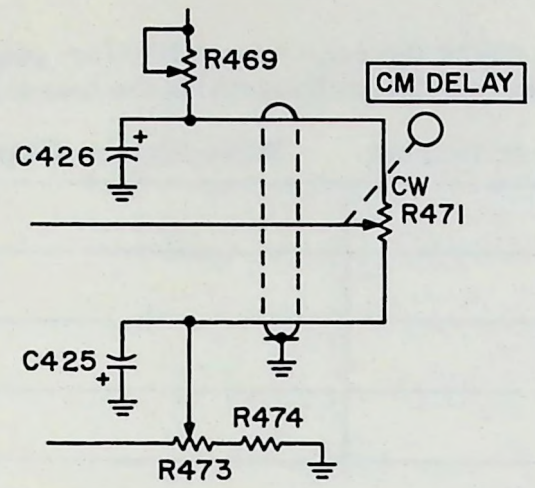
△ S302: Change according to Figure 2 (use designations within parentheses) and add R305.

Page 8-11, Figure 8-6, Schematic,

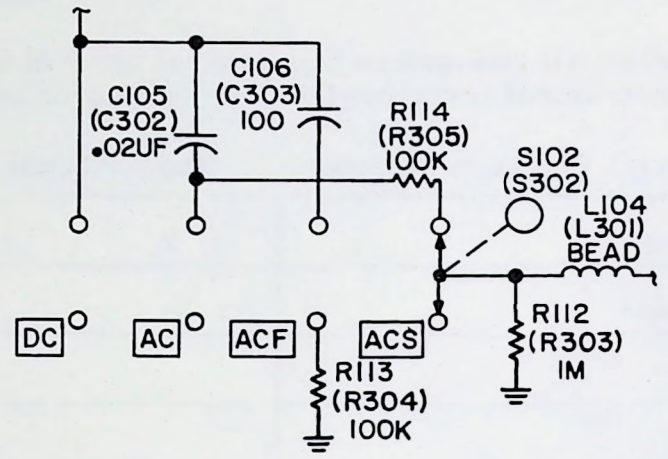
Add: L402; connect between Q406 gate and junction of CR411/S503.

Serial Prefix or Number	Make Manual Changes
630-	1, 2
644-	1, 3

Serial Prefix or Number	Make Manual Changes



△ Figure 1



△ Figure 2

△ CHANGE 2 Table 6-2, Miscellaneous,
hp Part No. 01821-00201: Change hp Part No. to 01821-00204.
hp Part No. 01821-60201: Change to hp Part No. 01821-60202; Panel: sub (includes S101 - S104 and S301 - S303).

△ CHANGE 3 Page 3-0, Figure 3-1,
Add: "13. INTENS RATIO. Screwdriver adjustment that controls the intensity ratio of the delayed sweep to the main sweep."
Page 3-7, Figure 3-7,
Figure 3-7. Single Sweep Operation: Change to read: "... Single Sweep Operation and Intensity Ratio Adjustment."
Add the following adjustment procedure:
INTENSITY RATIO ADJUSTMENT
A. Perform steps 1 through 5 of Figure 3-3.
B. Set main TIME/CM to 50 μsec and delayed TIME/CM to 5 μsec.
C. Set delayed Trigger Source to AUTO and CM DELAY to 2.
D. Adjust INTENS RATIO for desired intensity difference between normal and intensified portions of main sweep.
Page 5-1, Paragraph 5-10,
Add, following last sentence: "Perform Intensity Ratio Adjustment, Figure 3-7, before attempting Performance Check."
Page 5-3, Paragraph 5-27,
Add, following last sentence: "Set front panel adjustment, INTENS RATION, to midrange before attempting Adjustment Procedure."
Table 6-2,
Add: CR502, hp Part No. 1901-0040; CR: si; Mfr hp.
L401: Delete.
Add: P2, hp Part No. 1250-0898; P bulkhead connector, 1 pin, female; Mfr 98291; Mfr Part No. 52-146-0000.
R411: Change to hp Part No. 0757-0431; R: fxd, metflm, 2.43k ohms, 1%, 1/8w; Mfr hp.
R413: Change to hp Part No. 0757-0412; R: fxd, metflm, 365 ohms, 1% 1/8w; Mfr hp.
Add: R524; hp Part No. 0757-0280; R: fxd, metflm, 1k ohm, 1% 1/8w; Mfr hp.
Add: R525; hp Part No. 2100-2063; R: var, comp, 1k ohms, 10%, 1/2w, Mfr hp.

15 December 1966

Serial Prefix or Number	Make Manual Changes
630-	1, 2
644-	1, 3

Serial Prefix or Number	Make Manual Changes

Miscellaneous,
hp Part No. 01821-00201: Change to hp Part No. 01821-00205.
Add: hp Part No. 01821-04101; Plate: adapter (P2); Mfr hp.
Add: hp Part No. 01821-21702; Bushing (R525); Mfr hp.
hp Part No. 01821-60201: Change to hp Part No. 01821-60203.
hp Part No. 01821-61602: Change to hp Part No. 01821-61624.

Page 8-5, Figure 8-3, Schematic,
J1 Pin 14: Change to P2.

Page 8-11, Figure 8-6, Schematic,
L401: Delete; connect anode of CR401 to ground.

Page 8-13, Figure 8-7, Schematic,
S502: Replace with Figure 3.
S503: Delete the (947) wire shown at the OFF contact.

Page 8-14, Figure 8-8,
J1: Delete connections to pins 14 and 15. Connect -12.6vdc to pin 18.

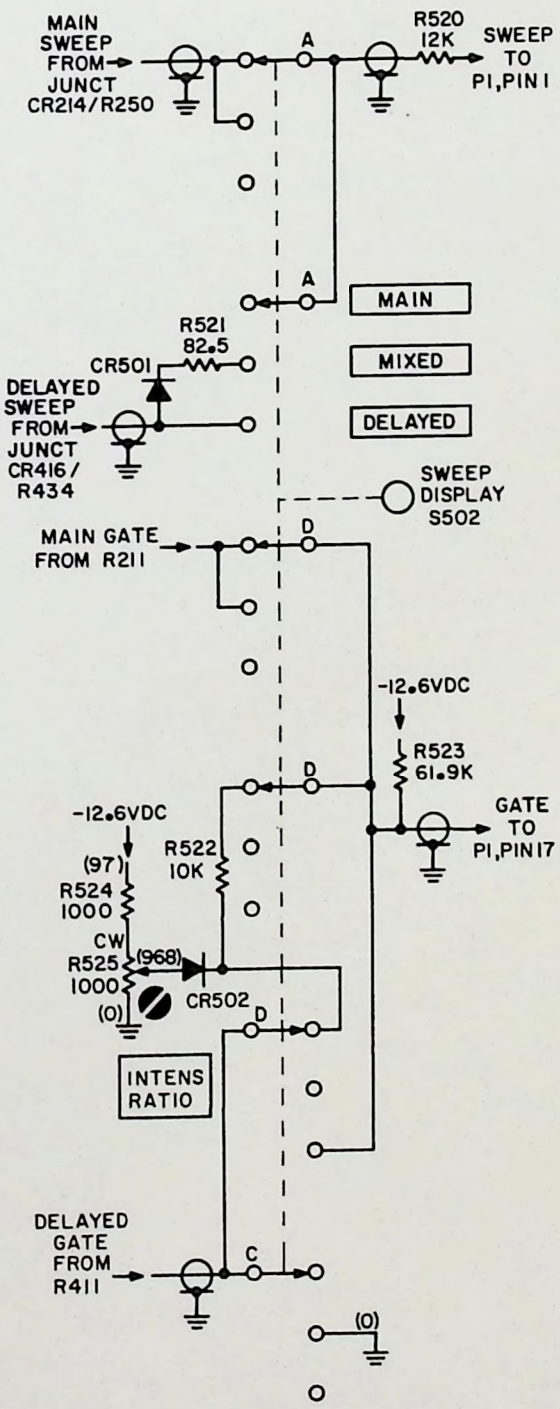


FIGURE 3

SECTION VIII
SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section combines detailed information including repair and replacement, component identification, schematic diagrams, and troubleshooting, all integrated with the appropriate schematic. Other information and procedures related to performance check and adjustment procedures are in Section V.

8-3. SCHEMATIC DIAGRAMS.

8-4. All schematic diagrams for the Model 1821A are in this section. (Refer to the List of Illustrations to locate a circuit by description). They are drawn to show the electronic function of the circuitry and a given schematic may include all or part of several different physical assemblies. Table 8-1 provides general schematic notes related to symbols and conventions used. The schematics also indicate waveform testpoints and typical dc voltages; refer to troubleshooting paragraph for details of interpreting waveform and dc voltages. Note that all schematics are printed so the entire schematic unfolds outside the right-hand edge of the manual.

8-5. COMPONENT IDENTIFICATION.

8-6. Identification of adjustments and chassis-mounted components by their reference designation is shown in Figure 8-2. Components located on etched circuit boards are identified, along with a grid location index, in pictures opposite the schematic diagram which applies. In cases where circuitry on an assembly appears on more than one schematic, refer to the grid index to determine which figure identifies the component of interest.

8-7. TROUBLESHOOTING.

8-8. GENERAL. Troubleshooting information in this manual applies directly only to the Model 1821A. Refer to the appropriate manual for information on other instruments. The most important prerequisite to systematic troubleshooting is an understanding of instrument circuitry operation. Refer to Section IV for a block diagram and principles of operation. To isolate a trouble to either the main frame oscilloscope or to the horizontal or vertical plug-in use the basic operating procedure given in Section III to isolate a trouble to a circuit associated with a front panel control. Also check for the proper outputs from the low and high voltage power supplies as these voltages affect the CRT display and operation of the plug-ins. Refer to Figure 8-3 for a troubleshooting tree which provides a means of elimination as a trouble certain of the circuits in this instrument. This in turn references, by circled-numbers, other specific circuit troubleshooting trees opposite the corresponding schematic diagram.

8-9. VISUAL INSPECTION. It is recommended that prior to using waveforms and dc voltages for troubleshooting, a thorough visual inspection of the instrument(s) be made. Check for burned or loose components, loose wire connections, faulty switch contacts, or any similar condition suggesting a source of the trouble. If the faulty operation is still present, proceed to the electrical checkout.

8-10. ELECTRICAL CHECKOUT. Typical waveforms are located near the schematic where appropriate. Always refer to the specified conditions for waveform measurement, given with the waveforms. Check the waveforms in a signal flow sequence; an incorrect waveform (or none) indicates the circuit likely to be at fault. Testpoints given on the schematics are shown at an electrical point which should be readily accessible on the etched circuit board at the physical/electrical corresponding point. Check the typical dc voltages (given on the schematic) in the suspect circuit to further isolate the trouble to a specific component. Conditions for dc voltages are given opposite the individual schematics. Always allow time for a stable dc voltage level to be reached before noting the reading. In

CAUTION

When measuring dc voltages, use extreme care to ensure that no supply voltages or components are shorted.

locating test points on the board assemblies, note that a small dot etched on the board identifies the emitter lead of transistors and the cathode lead of diodes.

Note

Where two dc voltages are shown on the schematic (one in parentheses), check carefully for the two different measurement conditions described opposite the schematic. When only one voltage appears, either set of measurement conditions applies.

8-11. REPAIR AND REPLACEMENT.

8-12. Almost all electrical components are accessible for replacement from the component side of the etched circuit boards. Component identification is summarized in Paragraph 8-5. Section VI provides a detailed parts list to allow ordering of replacements either from Hewlett-Packard or a typical manufacturer given. Mechanical and miscellaneous electrical parts are listed at the end of Table 6-2. If satisfactory operation or repair cannot be accomplished, contact the nearest Hewlett-Packard Sales/Service Office (addresses at rear of this manual). If shipment for repair is recommended, see Section II for recommended repackaging information.

8-13. SERVICING CIRCUIT BOARDS.

8-14. Etched circuit boards in this instrument have components mounted on one side of the board, conductive surfaces on both sides, and plated-through component mounting holes. Hewlett-Packard Service Note M-20D contains useful information on servicing etched circuit boards. Important considerations are as follows:

a. Use low heat (37 to 47.5 watts, less than 800°F idling temperature), slightly bent chisel type (1/16 to 1/8 inch diameter) soldering iron; and a small diameter, high tin content solder. If a rosin solder is used clean the area thoroughly after soldering.

b. Components may be removed by placing the soldering iron on the component lead on either side of the board, and pulling up on the lead. If heat is applied to the component side of the board, greater care is required to avoid damage to the component (especially true for semiconductors). If heat damage may occur, grip the lead with a pair of pliers to provide a heat sink between the soldering iron and component.

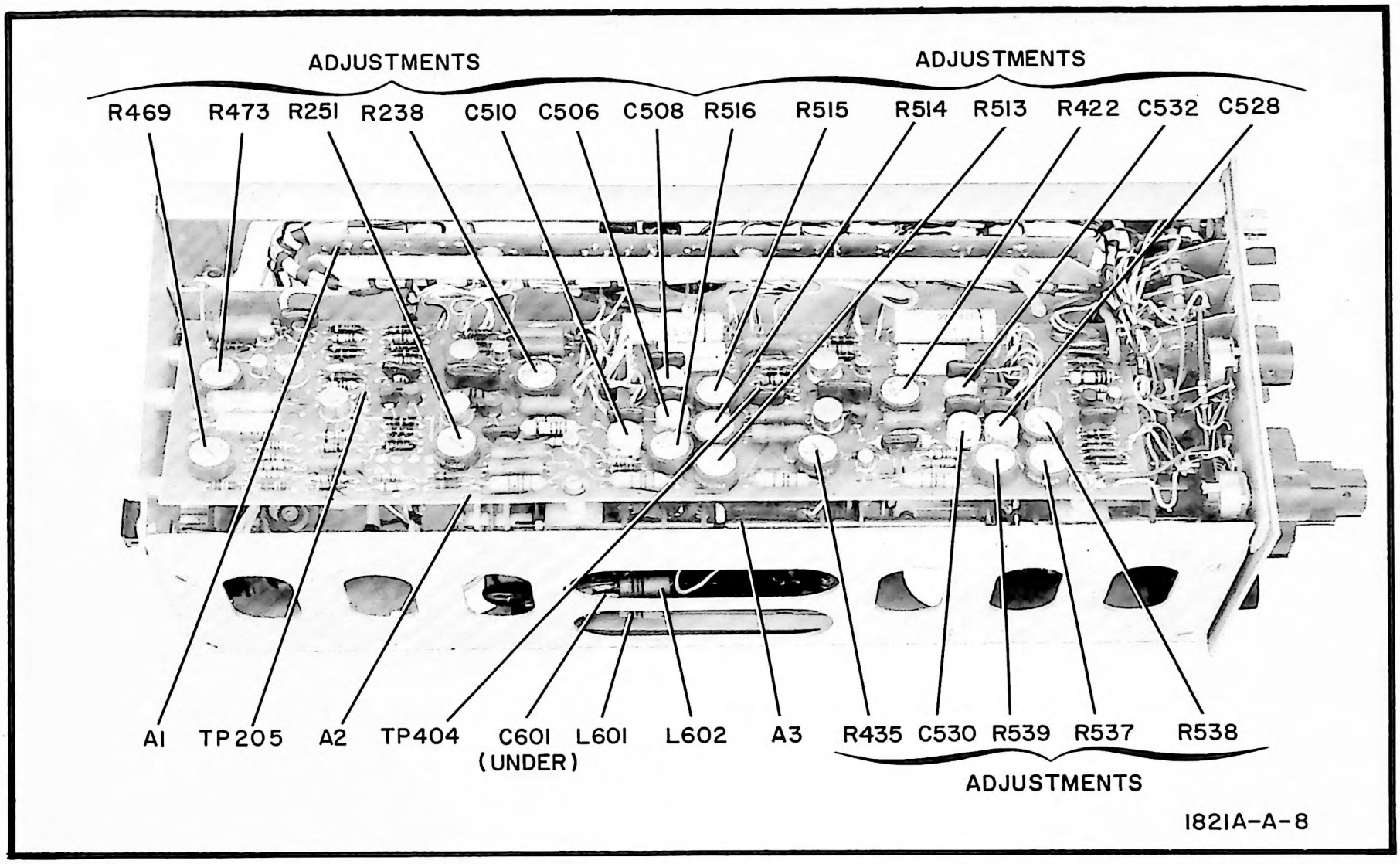
c. If a component is obviously damaged or faulty, clip the leads close to the component and then unsolder the leads from the board.

d. Large components such as potentiometers may be removed by rotating the soldering iron from lead to lead and applying steady pressure to lift the part free (the alternative is to clip the leads of a damaged part).

e. Since the conductor portion of the etched circuit board is a metal plated surface covered with solder, use care to avoid overheating which causes the conductor to lift away from the board. A lifted conductor may be cemented back in place with a quick-drying acetate base cement (use sparingly) having good insulating properties. Another method of repair is to solder a section of good conducting wire along the damaged area.

f. Clear the solder from the component hole before inserting a new component lead. Heat the solder in the hole, remove the iron, and quickly insert a pointed non-metalic object, such as a toothpick.

g. Shape the new component leads and clip to proper length. Insert the leads into the holes, apply heat and solder (preferably on the side opposite the component)



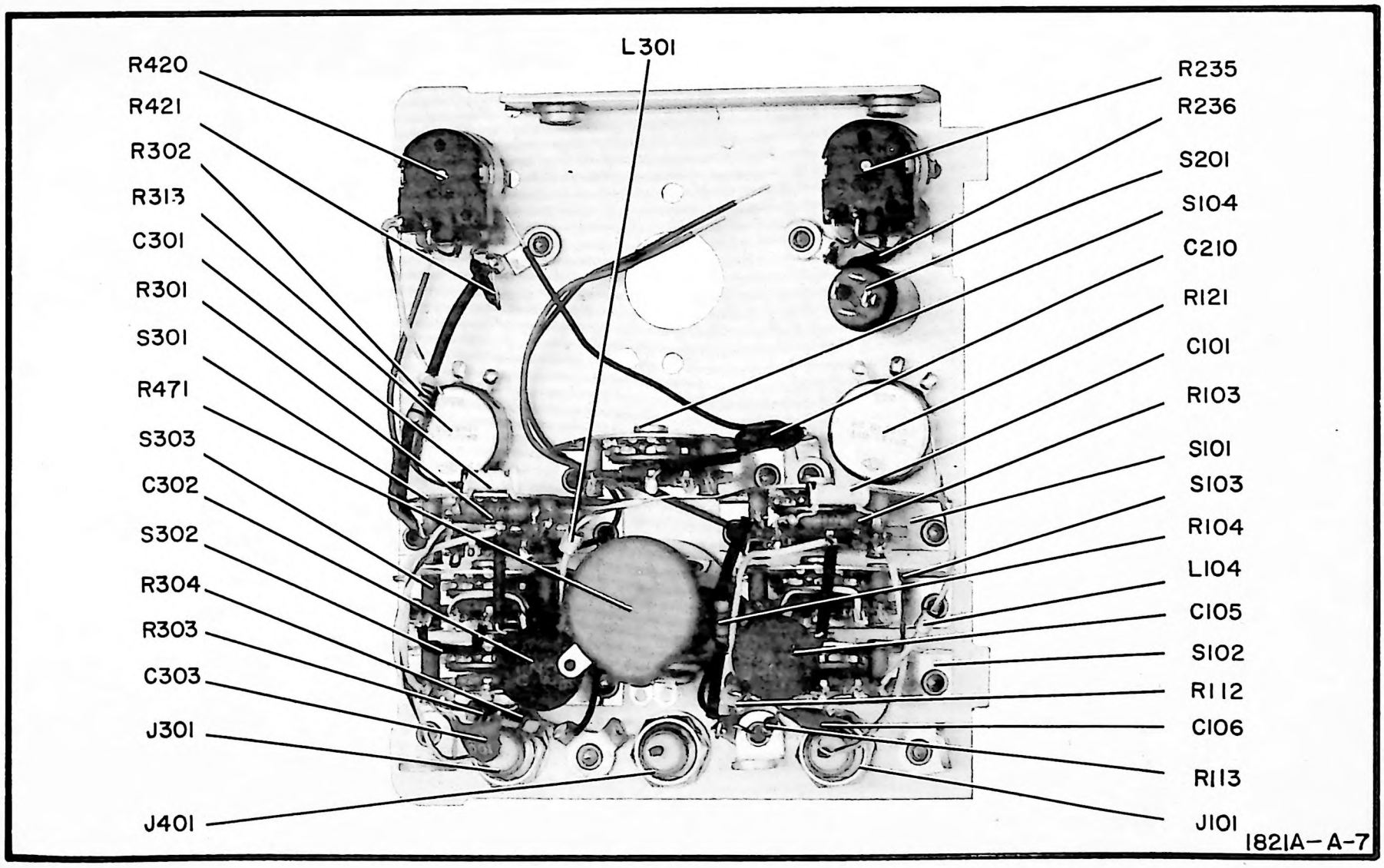
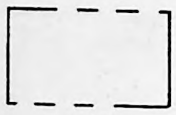


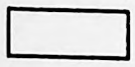
Figure 8-2. Adjustment Location and Component Identification

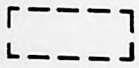
Table 8-1. Schematic Diagram Notes

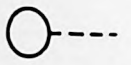
Refer to MIL-STD-15-1 for schematic symbols not listed in this table.

Unless otherwise indicated:
capacitance in picofarads
inductance in microhenries
resistance in ohms


= Etched circuit board


= Front panel marking


= Rear panel marking


= Front panel control


= Screwdriver Adjustment

CW = Clockwise end of variable resistor

= Primary signal path

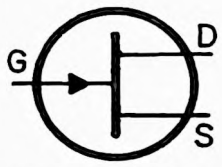
= Secondary Signal Path


= Waveform test point (with number)


= Common point (with letter)


= Avalanche (zener) diode


= Tunnel diode



= Field Effect Transistor (N-channel)

Numbers in parentheses indicate wire color using resistor color code, e.g. WHT-RED-GRN is (9·2·5).

0 - Black	5 - Green
1 - Brown	6 - Blue
2 - Red	7 - Violet
3 - Orange	8 - Gray
4 - Yellow	9 - White

P/O = Part of

* = Optimum value selected at factory, average value shown; part may have been omitted.

N.C. = No connection

02591-1

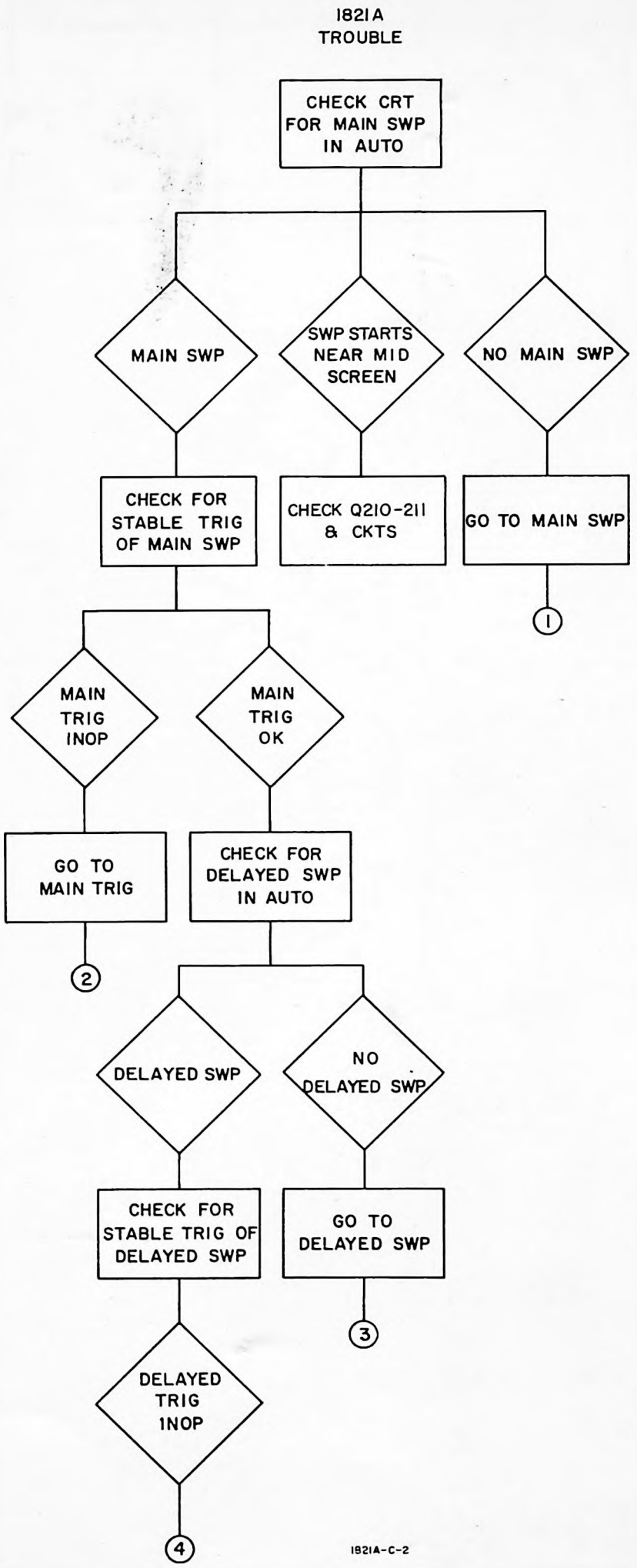


Figure 8-1. Over-all Troubleshooting Tree

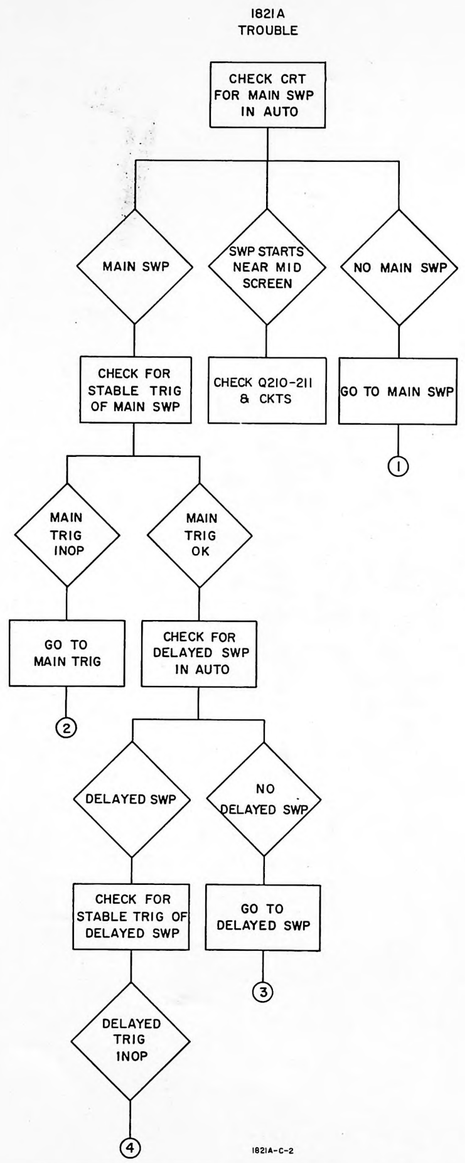
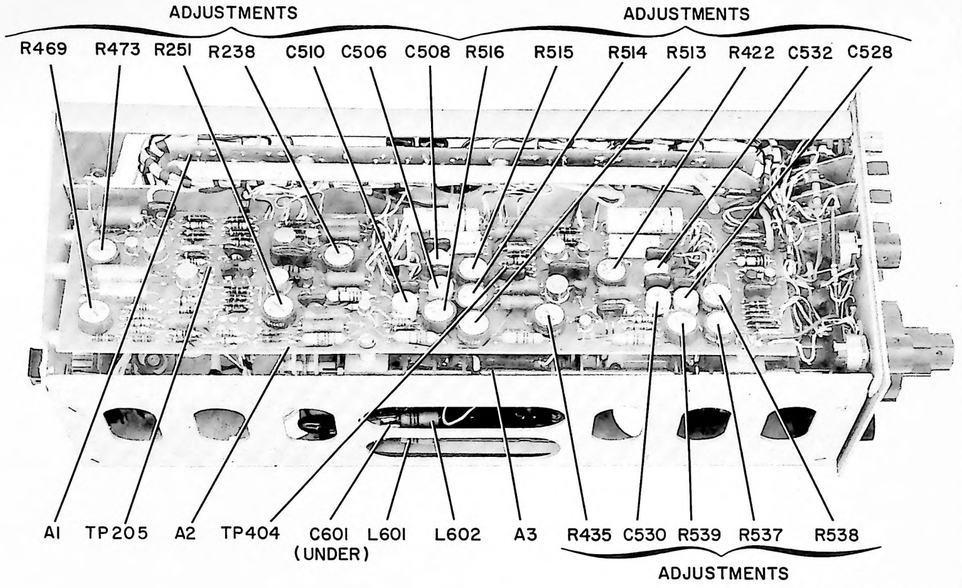


Figure 8-1. Over-all Troubleshooting Tree



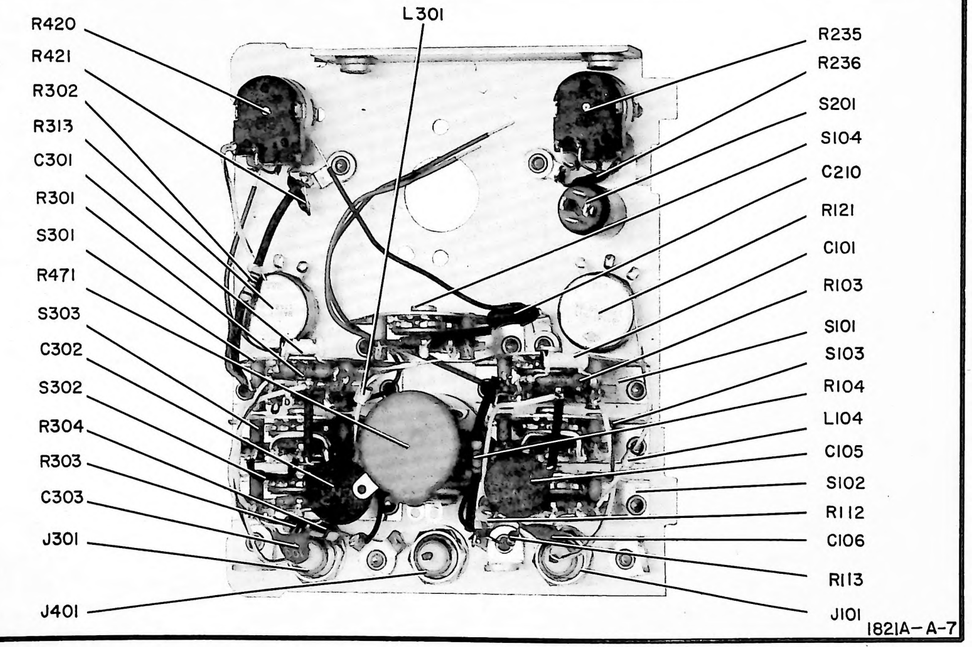
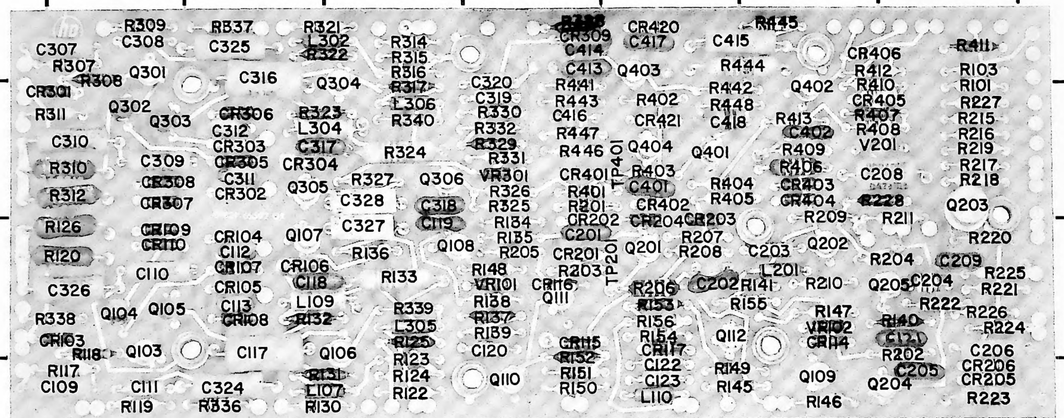


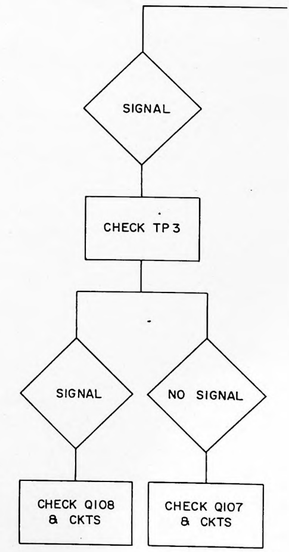
Figure 8-2. Adjustment Location and Component Identification

	A	B	C	D	E	F	G	H	I	J	K	
1												1
2												2
3												3
4												4
5												5

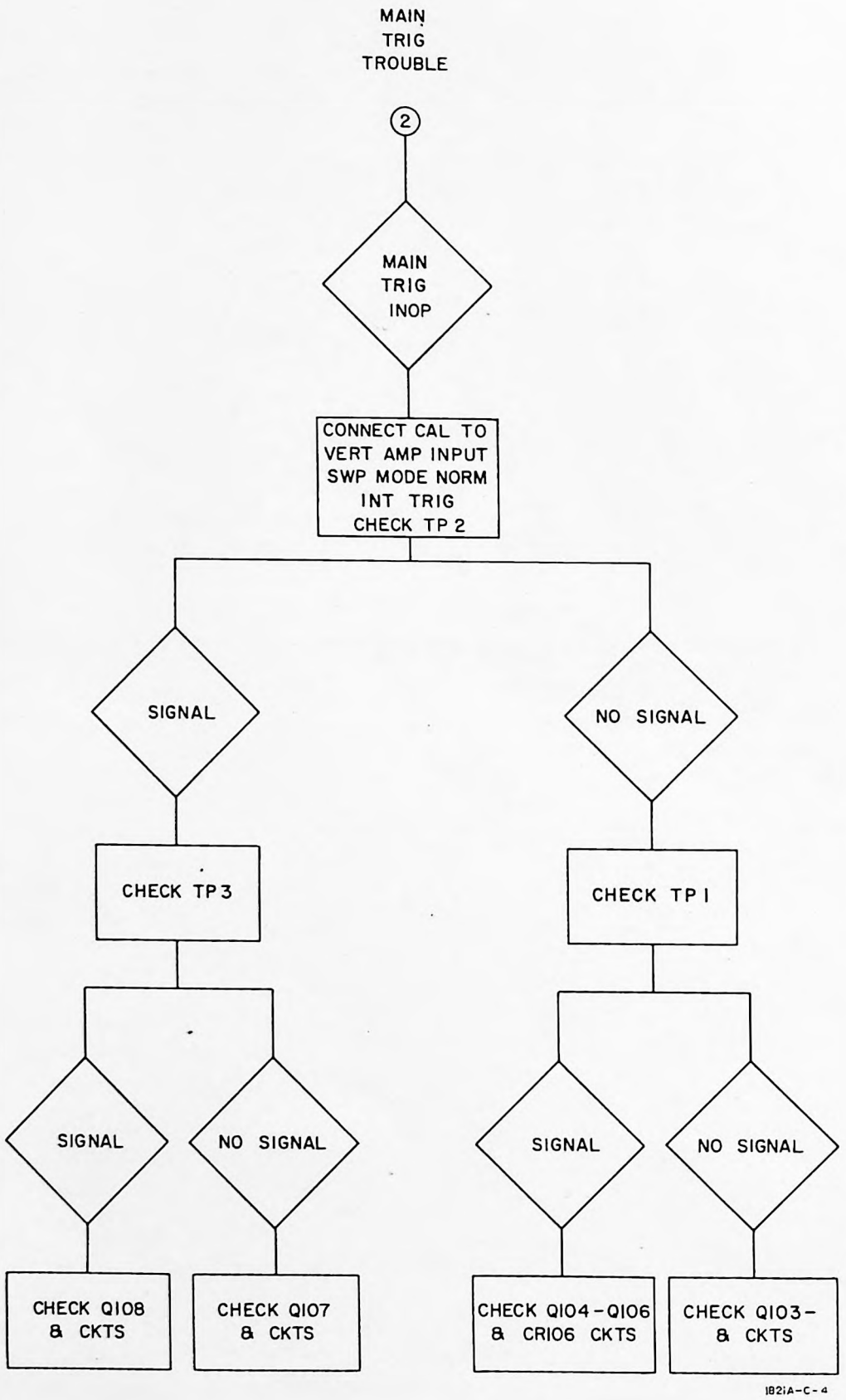


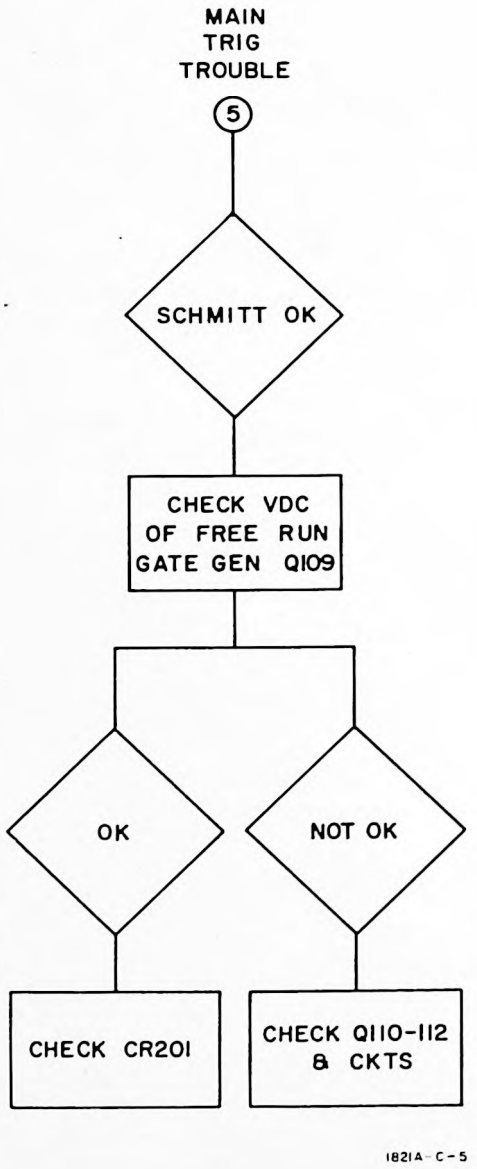
REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C109	C5	C310	C3	CR105	D4	CR308	C3	Q108	E4	R117	C5	R146	H5	R215	I3	R316	E2	R405	G3
C110	C4	C311	D3	CR106	D4	CR309	F2	Q109	H5	R118	C4	R147	H4	R216	I3	R317	E3	R406	H3
C111	C5	C312	D3	CR107	D4	CR401	F3	Q110	F5	R119	C5	R148	F4	R217	I3	R321	D2	R407	H3
C112	D4	C316	D2	CR108	D4	CR402	G3	Q111	F4	R120	C4	R149	G5	R218	I3	R322	D2	R408	H3
C113	D4	C317	D3	CR109	C4	CR403	H3	Q112	G4	R122	E5	R150	F5	R219	I3	R323	D3	R409	H3
C117	D4	C318	E3	CR110	C4	CR404	H3	Q201	G4	R123	E5	R151	F5	R220	I4	R324	E3	R410	H3
C118	D4	C319	F3	CR114	H4	CR405	H3	Q202	H4	R124	E5	R152	F4	R221	I4	R325	F3	R411	I2
C119	E4	C320	F3	CR115	F4	CR406	H2	Q203	I3	R125	E4	R153	G4	R222	I4	R326	F3	R412	H2
C120	F4	C324	D5	CR116	F4	CR420	G2	Q204	I5	R126	C4	R154	G4	R223	I5	R327	E3	R413	H3
C121	I4	C325	D2	CR117	G4	CR421	G3	Q205	I4	R130	D5	R155	H4	R224	I4	R328	F2	R441	F3
C122	G5	C326	C4	CR201	F4	L107	D5	Q301	C2	R131	D5	R156	G4	R225	I4	R329	F3	R442	G3
C123	G5	C327	E4	CR202	F4	L109	D4	Q302	C3	R132	D4	R201	F3	R226	I4	R330	F3	R443	F3
C201	F4	C328	E3	CR203	G3	L110	G5	Q303	C3	R133	E4	R202	I4	R227	I3	R331	F3	R444	G2
C202	G4	C401	G3	CR204	G4	L201	H4	Q304	E3	R134	F4	R203	F4	R228	H3	R332	F3	R445	H2
C203	H4	C402	H3	CR205	I5	L302	D2	Q305	D4	R135	F4	R204	I4	R307	C2	R336	D5	R446	F3
C204	I4	C413	F2	CR206	I5	L304	D3	Q306	E3	R136	E4	R205	F4	R308	C2	R337	D2	R447	F3
C205	I5	C414	G2	CR301	C3	L305	E4	Q401	G3	R137	F4	R206	G4	R309	C2	R338	C4	R448	G3
C206	I4	C415	G2	CR302	D3	L306	E3	Q402	H3	R138	F4	R207	G4	R310	C3	R339	E4	TP201	G4
C208	H3	C416	F3	CR303	D3	Q103	C4	Q403	G2	R139	F4	R208	G4	R311	C3	R340	E3	TP401	G3
C209	I4	C417	G2	CR304	D3	Q104	C4	Q404	G3	R140	I4	R209	H3	R312	C3	R401	F3	V201	H3
C307	C2	C418	G3	CR305	D5	Q105	C4	R101	I3	R141	H4	R210	H4	R314	E2	R402	G3	VR101	F4
C308	C2	CR103	C4	CR306	D3	Q106	E4	R102	I2	R145	G5	R211	I3	R315	E2	R403	G3	VR102	H4
C309	C3	CR104	D4	CR307	C3	Q107	D4									R404	G3	VR301	F3

1821A-B-2



Component Identification
for A2 in Figure 8-4





DC VOLTAGE MEASUREMENT CONDITIONS

1. Initial Control Settings

horizontal DISPLAY	INT
SWEEP MODE	AUTO
main TRIGGER LEVEL	fully cw
main Trigger Source	EXT ÷ 10
main SLOPE	+
main Trigger Coupling	DC

All voltages not in parentheses are measured after making initial control settings.

2. Voltages in parentheses are measured after making initial control settings with exceptions shown below:

Level Emitter Follower, Trigger Comparator, and Trigger Generator circuit.
main TRIGGER LEVEL · · · · · · · · · fully ccw

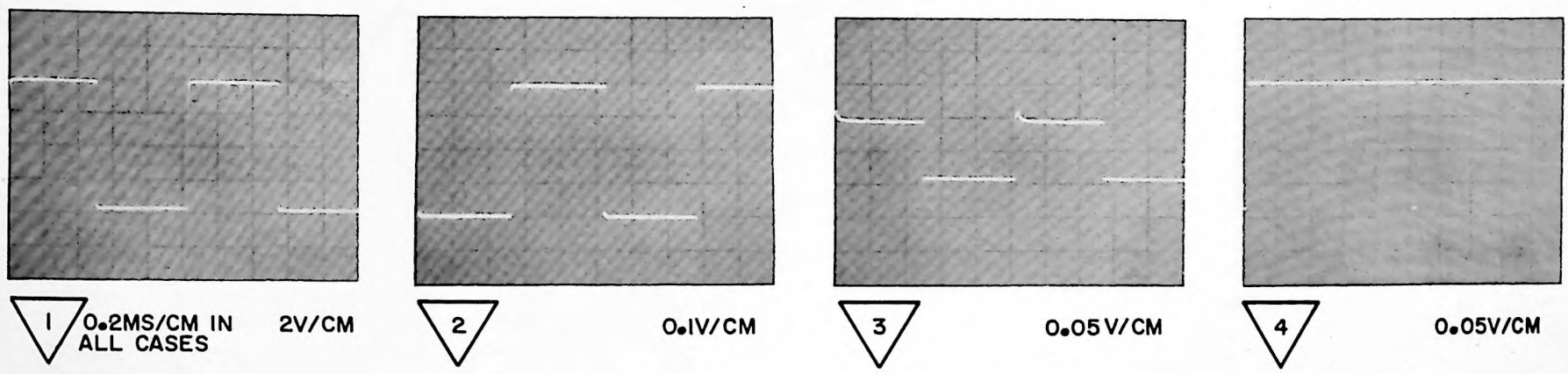
Monostable Multivibrator, Free Run Lockout, and Free Run Gate Generator circuits.
SWEEP MODE · · · · · · · · · · · · · · · SINGLE

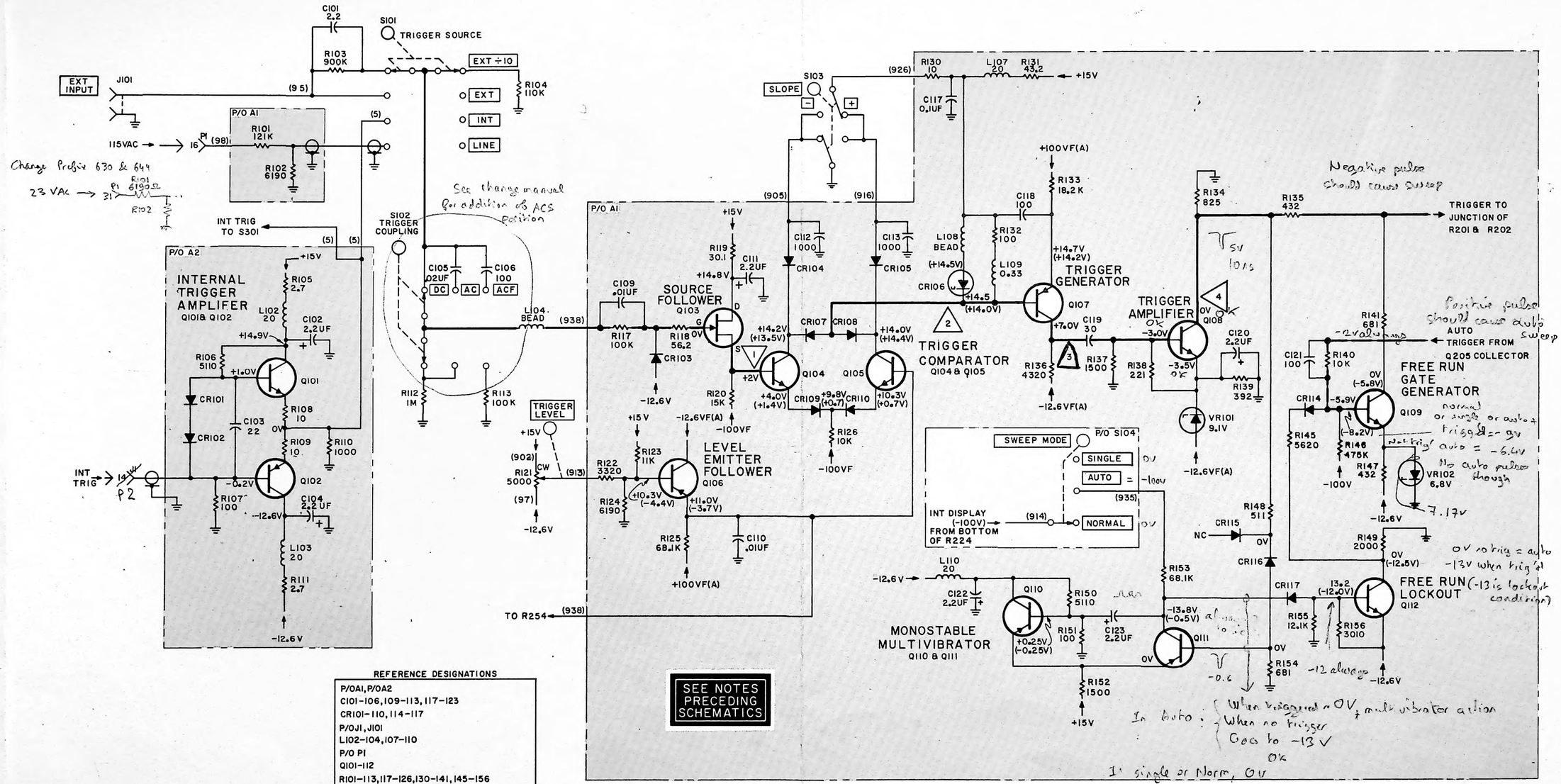
WAVEFORM MEASUREMENT CONDITONS

1. Initial Control Settings

main TRIGGER LEVEL	0
main Trigger Source	EXT
main SLOPE	+
main Trigger Coupling	AC

Connect the 1 kHz, 10V, pk-pk square wave from the Model 180A/AR CALIBRATOR to main EXT INPUT.





REFERENCE DESIGNATIONS

P/OA1, P/OA2
C101-106, 109-113, 117-123
CR101-110, 114-117
P/OJ1, J101
L102-104, 107-110
P/O P1
Q101-112
R101-113, 117-126, 130-141, 145-156
S101-104
VR101, 102
DELETED:

4/86 CHANGED Q108 to 2N930A MAY BE TOO SLOW

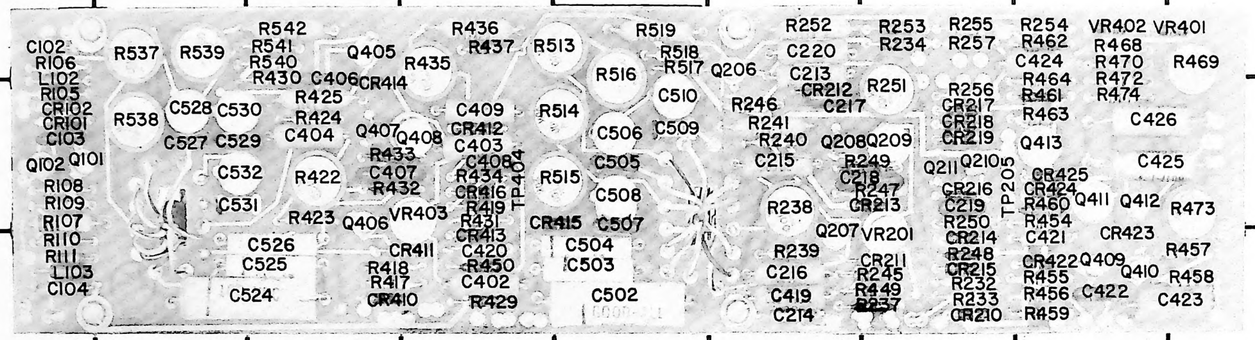
4 0.05V/CM

1821A-8-6

p/o Figure 8-3. Main Trigger

Section
p/o Fig

	A	B	C	D	E	F	G	H	I	J	K	
1												1
2												2
3												3
4												4
5												5
6												6



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C102	B2	C409	E3	C510	F3	CR216	H3	Q101	B3	R105	B3	R246	G3	R423	D3	R456	I4	R515	E3
C103	B3	C419	G4	C524	C4	CR217	H3	Q102	B3	R106	B2	R247	H3	R424	D3	R457	J4	R516	F2
C104	B4	C420	E4	C525	D4	CR218	H3	Q206	G2	R107	B3	R248	H4	R425	D3	R458	J4	R517	F2
C213	G3	C421	I4	C526	D4	CR219	H3	Q207	G4	R108	B3	R249	G3	R429	E4	R459	I4	R518	F2
C214	G4	C422	I4	C527	C3	CR410	D4	Q208	G3	R109	B3	R250	H3	R430	D3	R460	I3	R519	F2
C215	G3	C423	J4	C528	C3	CR411	D4	Q209	H3	R110	B4	R251	H3	R431	E3	R416	I3	R537	C2
C216	G4	C424	I2	C529	C3	CR412	E3	Q210	H3	R111	B4	R252	G2	R432	D3	R462	I2	R538	C3
C217	G3	C425	I3	C530	C3	CR413	E4	Q211	H3	R232	H4	R253	H2	R433	D3	R463	I3	R539	C2
C218	G3	C426	I3	C531	C3	CR414	D3	Q405	D2	R233	H4	R254	I2	R434	E3	R464	I3	R540	D2
C219	H3	C502	F4	C532	C3	CR415	E3	Q406	D3	R234	H2	R255	H2	R435	E2	R468	I2	R541	D2
C220	G2	C503	F4	CR101	B3	CR416	E3	Q407	D3	R237	H4	R256	H3	R436	E2	R469	J2	R542	D2
C402	E4	C504	F4	CR102	B3	CR422	I4	Q408	E3	R238	G3	R257	H2	R437	E2	R470	I2	TP205	H3
C403	E3	C505	F3	CR210	H4	CR423	I4	Q409	I4	R239	G2	R417	D4	R449	H4	R472	I3	TP404	E3
C404	D3	C506	F3	CR211	H3	CR424	I3	Q410	I4	R240	G3	R418	D4	R450	E4	R473	J3	VR201	H4
C406	D3	C507	F3	CR213	G3	CR425	I3	Q411	I3	R241	G3	R419	E3	R454	I3	R474	I3	VR401	J2
C407	D3	C508	F3	CR214	H4	L102	B3	Q412	I3	R245	H4	R422	D3	R455	I3	R513	E2	VR402	I2
C408	E3	C509	F3	CR215	H5	L103	B4	Q413	I3							R514	E3	VR403	E3

1821A—B—3

SIG

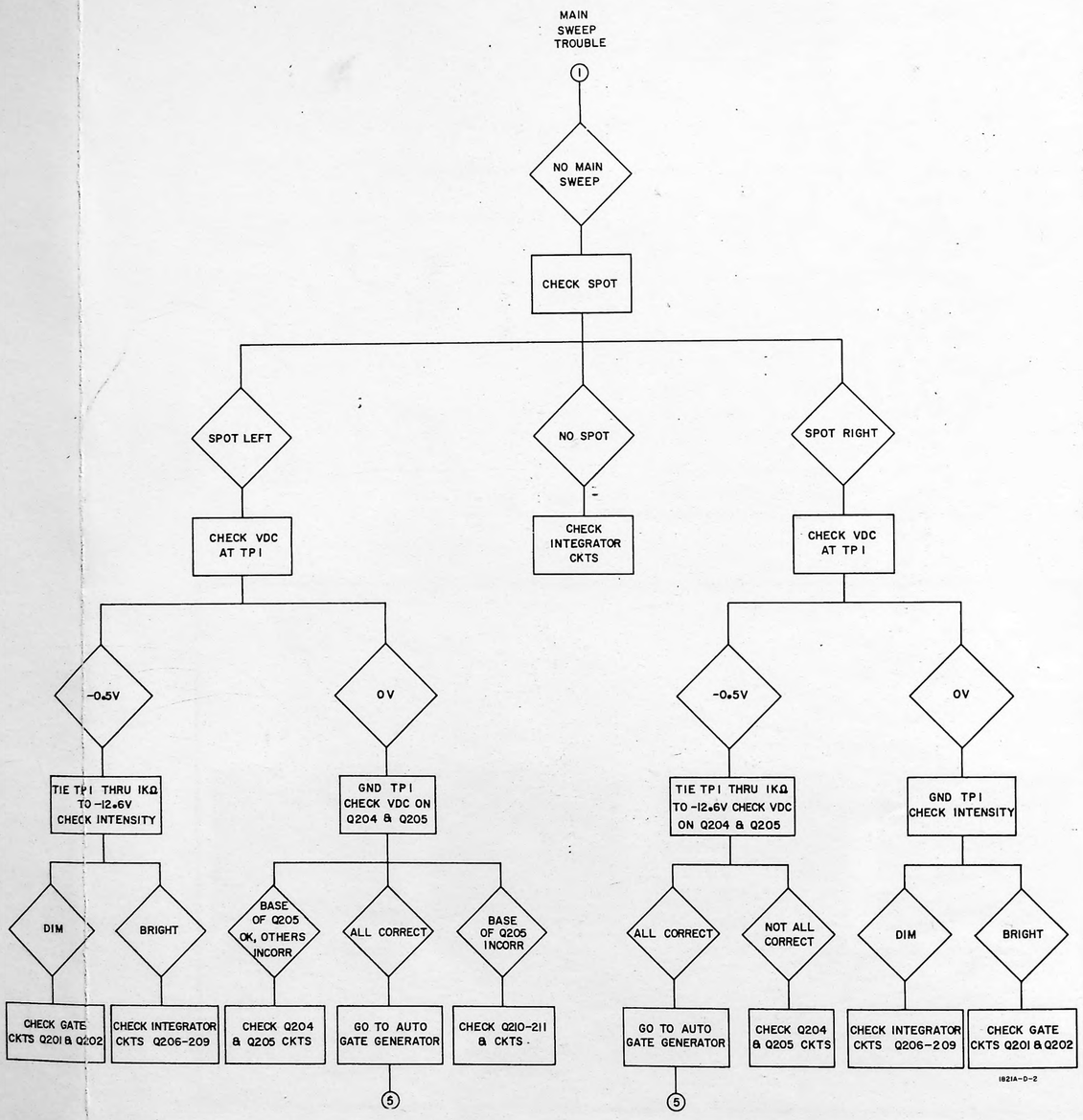
CHECK
& C

DIM

CHECK GATE
CKTS Q201 & Q

8-4

Component Identification for A1 in Figure 8-3



DC VOLTAGE MEASUREMENT CONDITIONS

1. Initial Control Settings

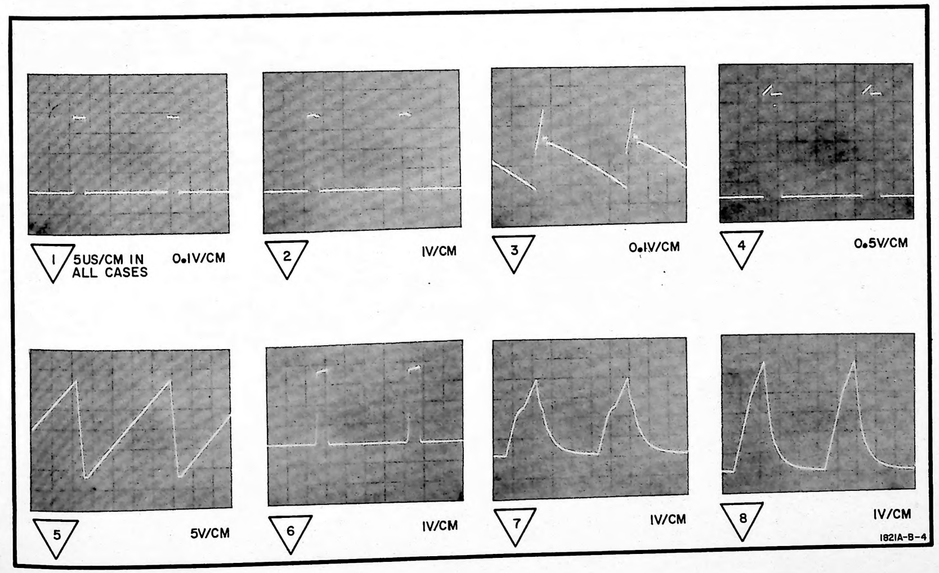
   horizontal DISPLAY . . . . . INT
   main VERNIER . . . . . CAL
   Sweep Display . . . . . MAIN
   main TIME/CM . . . . . 1 μSEC
   SWEEP MODE . . . . . AUTO

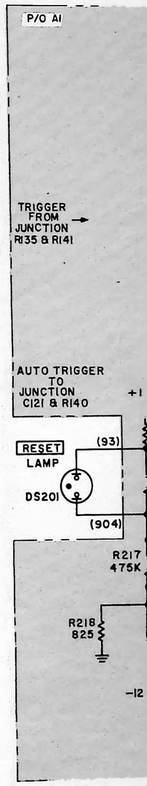
   All voltages not in parentheses are measured with TP201 grounded

2. Voltages in parentheses are measured with TP201 connected through a 1k ohm resistor to -12.6 vdc.

WAVEFORM MEASUREMENT CONDITIONS

Main VERNIER . . . . . CAL
SWEEP MODE . . . . . AUTO
Main TIME/CM . . . . . 2 μSEC





CONDITIONS

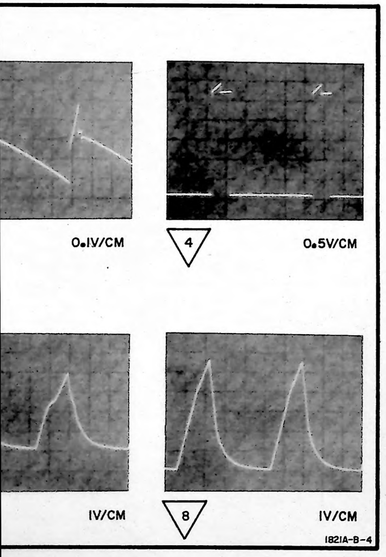
· · · · · · · · · · INT
· · · · · · · · · · CAL
· · · · · · · · · · MAIN
· · · · · · · 1 μSEC
· · · · · · · · · · AUTO

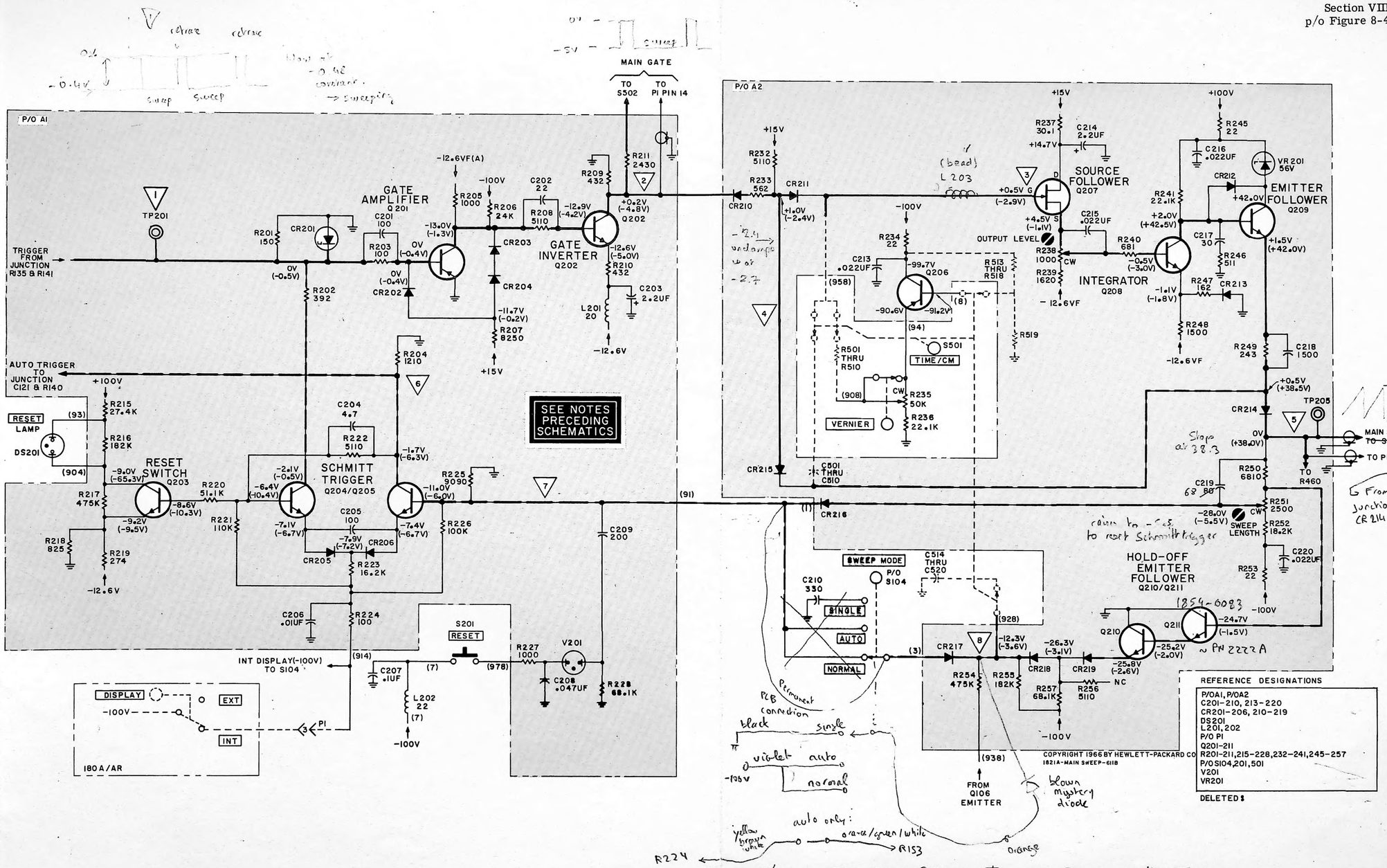
measured with TP201

ed with TP201
r to -12.6 vdc.

ONDITIONS

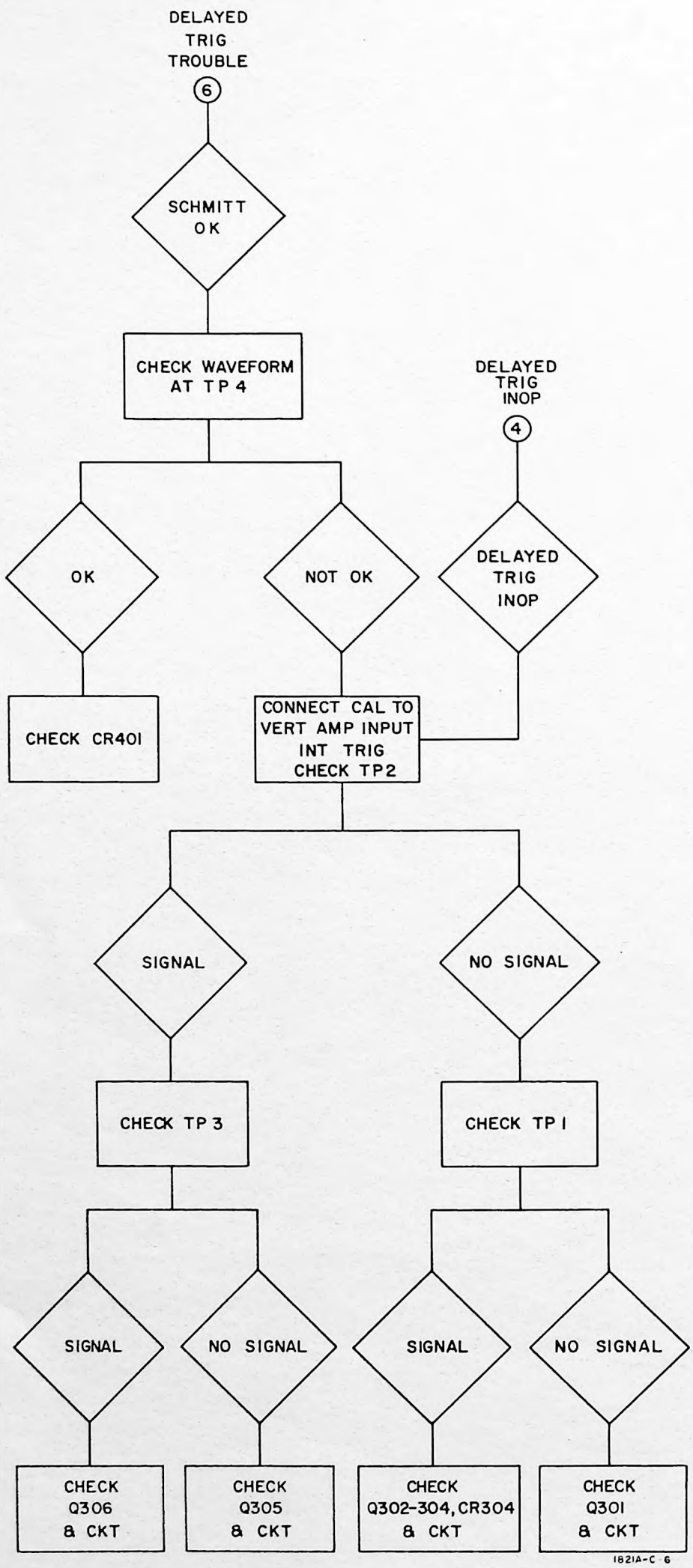
· · · · · · · · · · CAL
· · · · · · · · · · AUTO
· · · · · · · 2 μSEC





p/o Figure 8-4. Main Sweep

Component Identification
for A1 in Figure 8-3



DC VOLTAGE MEASUREMENT CONDITIONS

1. Initial Control Settings

horizontal DISPLAY	INT
SWEEP TIME	AUTO
delayed TRIGGER LEVEL	fully cw
delayed Trigger Source	EXT ÷ 10
delayed SLOPE	+
delayed Trigger Coupling	DC

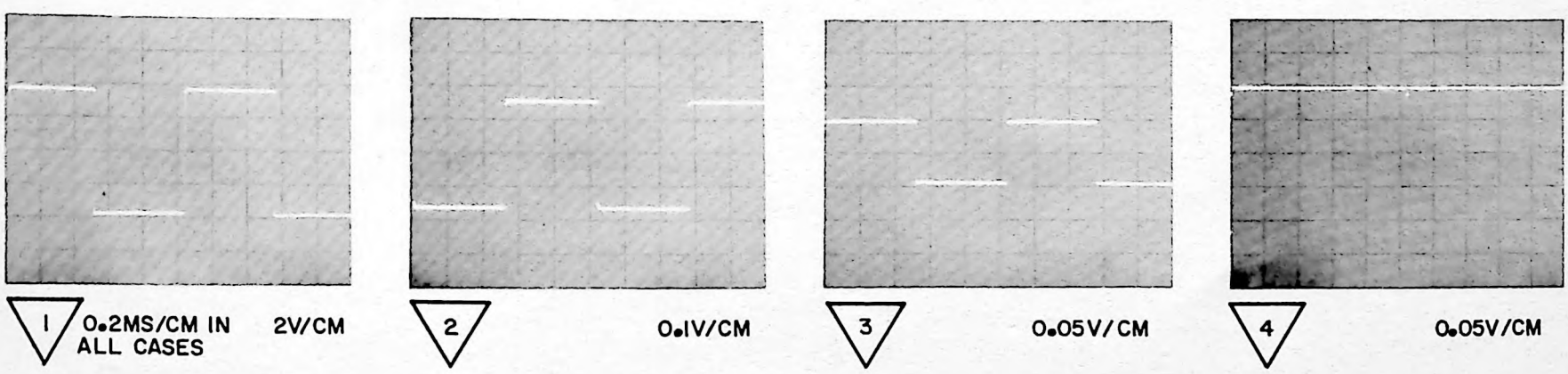
All voltages not in parentheses are measured after making initial control settings.

2. Voltages in parentheses are measured after making initial control settings and rotating delayed TRIGGER LEVEL fully ccw.

WAVEFORM MEASUREMENT CONDITIONS

delayed TRIGGER LEVEL	0
delayed Trigger Source	EXT
delayed SLOPE	+
delayed Trigger Coupling	AC

Connect the 1 kHz, 10V, pk-pk square wave from the Model 180A/AR CALIBRATOR to main and delayed EXT INPUT.



NDITIONS

. . . . . INT
. . . . . AUTO
. . . . . fully cw
. . . EXT ÷ 10
. . . . . +
. . . . . DC

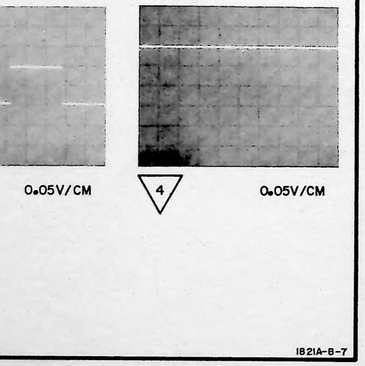
sured after mak-

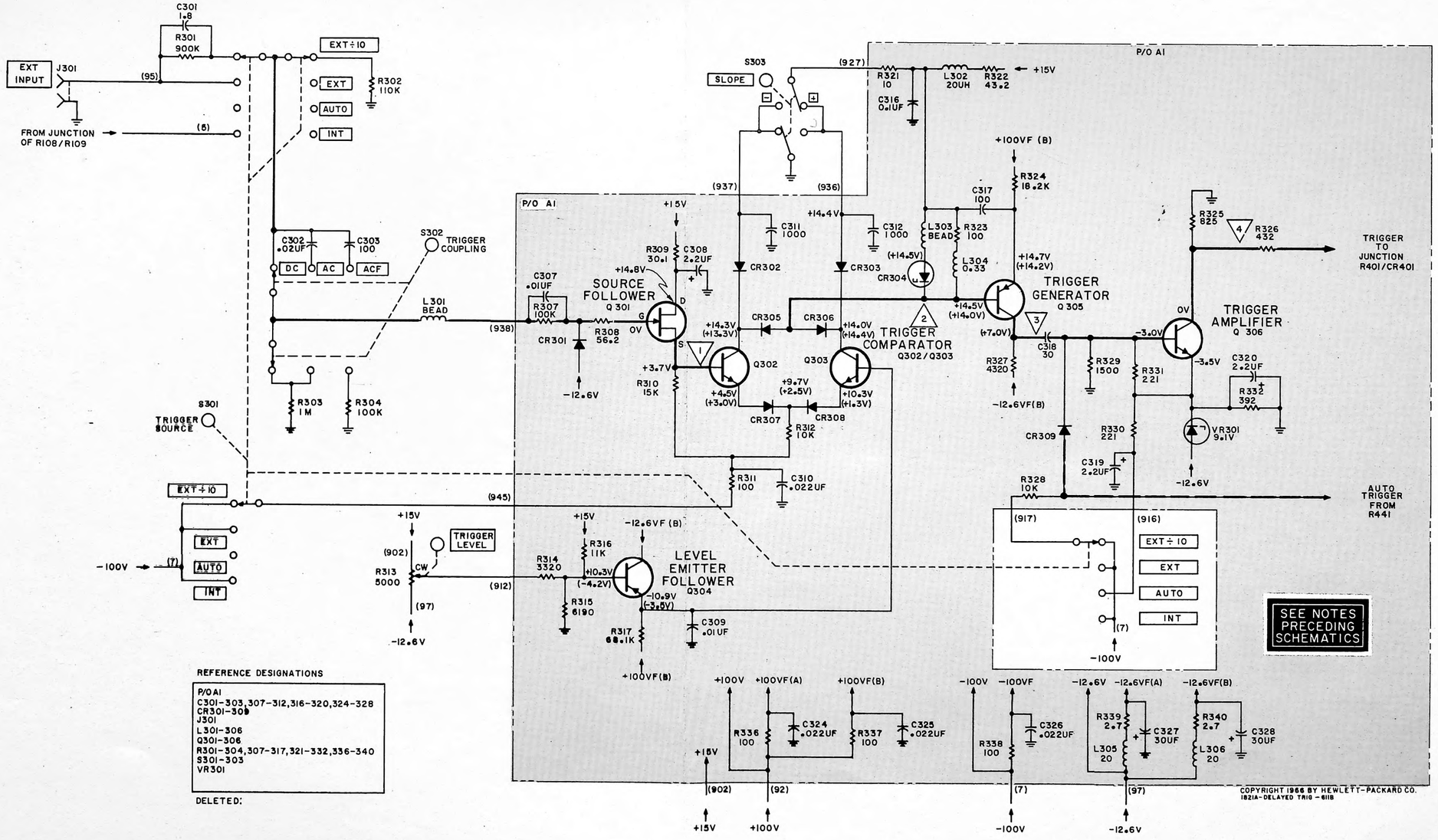
ter making initial
RIGGER LEVEL

ITIONS

. 0
. . . . . EXT
. . . . . +
. . . . . AC

e from the Model
d EXT INPUT.

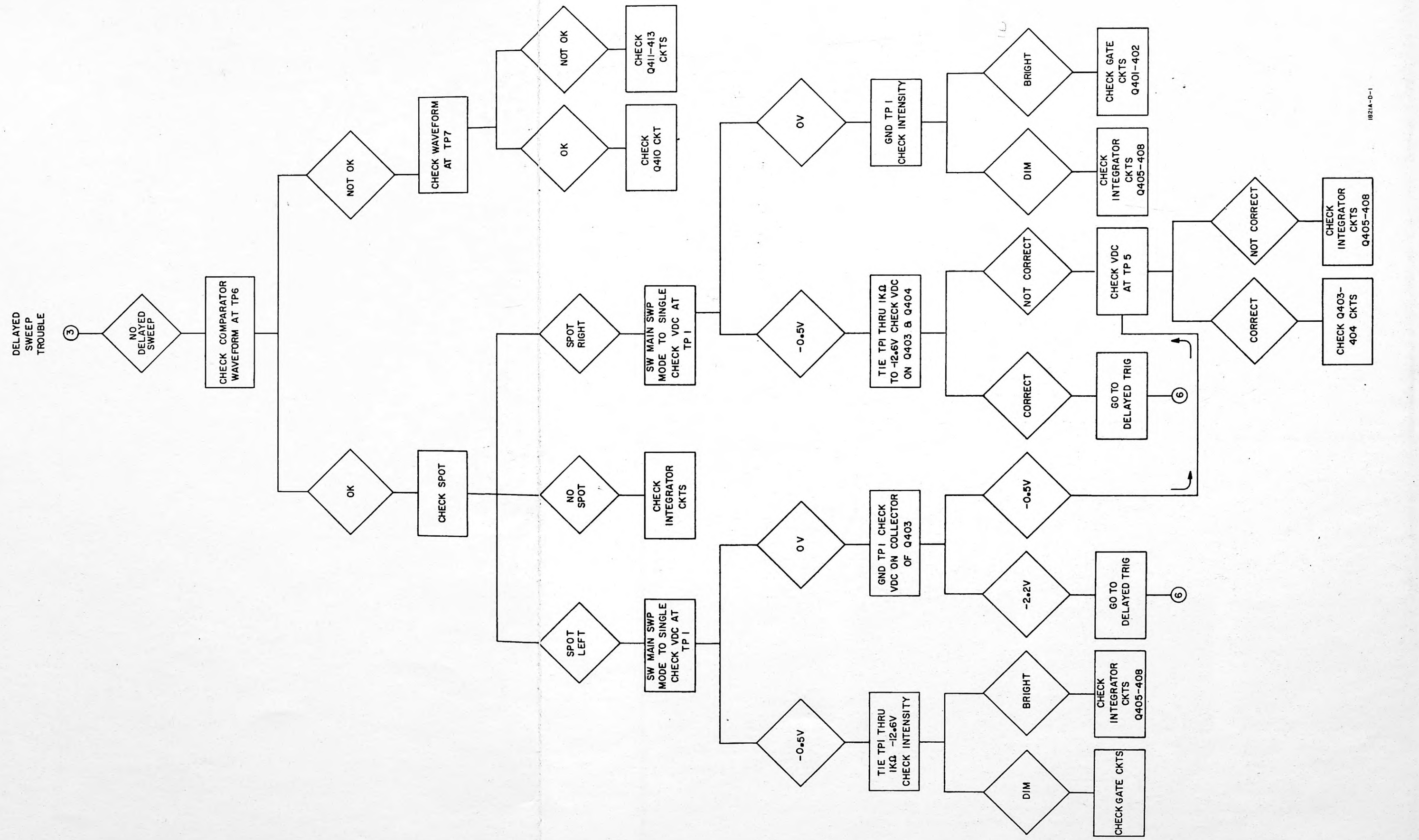




p/o Figure 8-5. Delayed Trigger

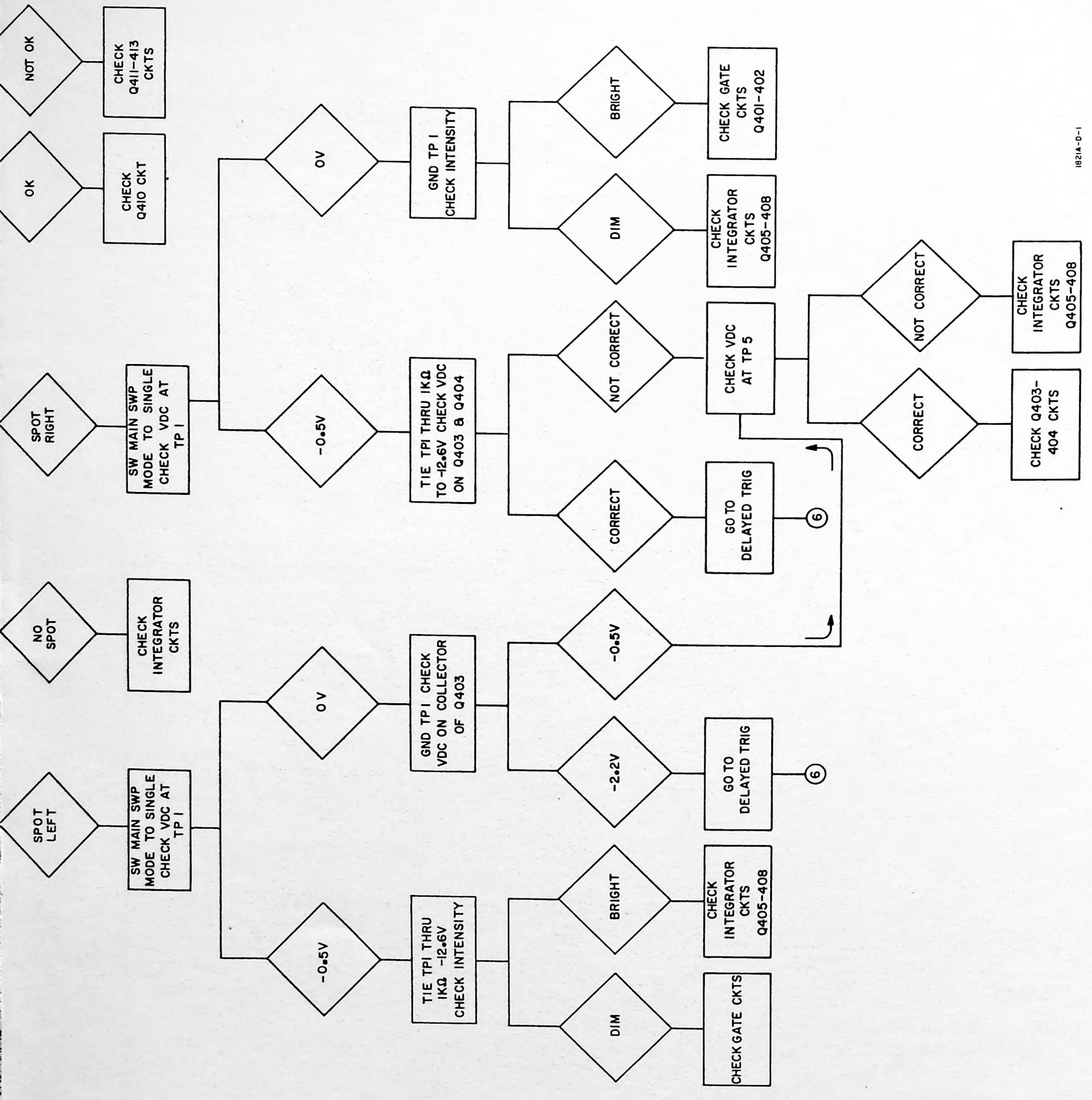
Component Identification
for A1 in Figure 8-3

Component Identification
for A2 in Figure 8-4



Component Identification for A1 in Figure 8-3

Component Identification for A2 in Figure 8-4



DC VOLTAGE MEASUREMENT CONDITIONS

1. Initial Control Settings

horizontal DISPLAY	INT
Sweep Display	MAIN
delayed TIME/CM	0.2 μSEC
delayed VERNIER	CAL
CM DELAY	4:00

All voltages in parentheses are measured with TP401 connected through a 1k ohm resistor to -12.6 vdc.

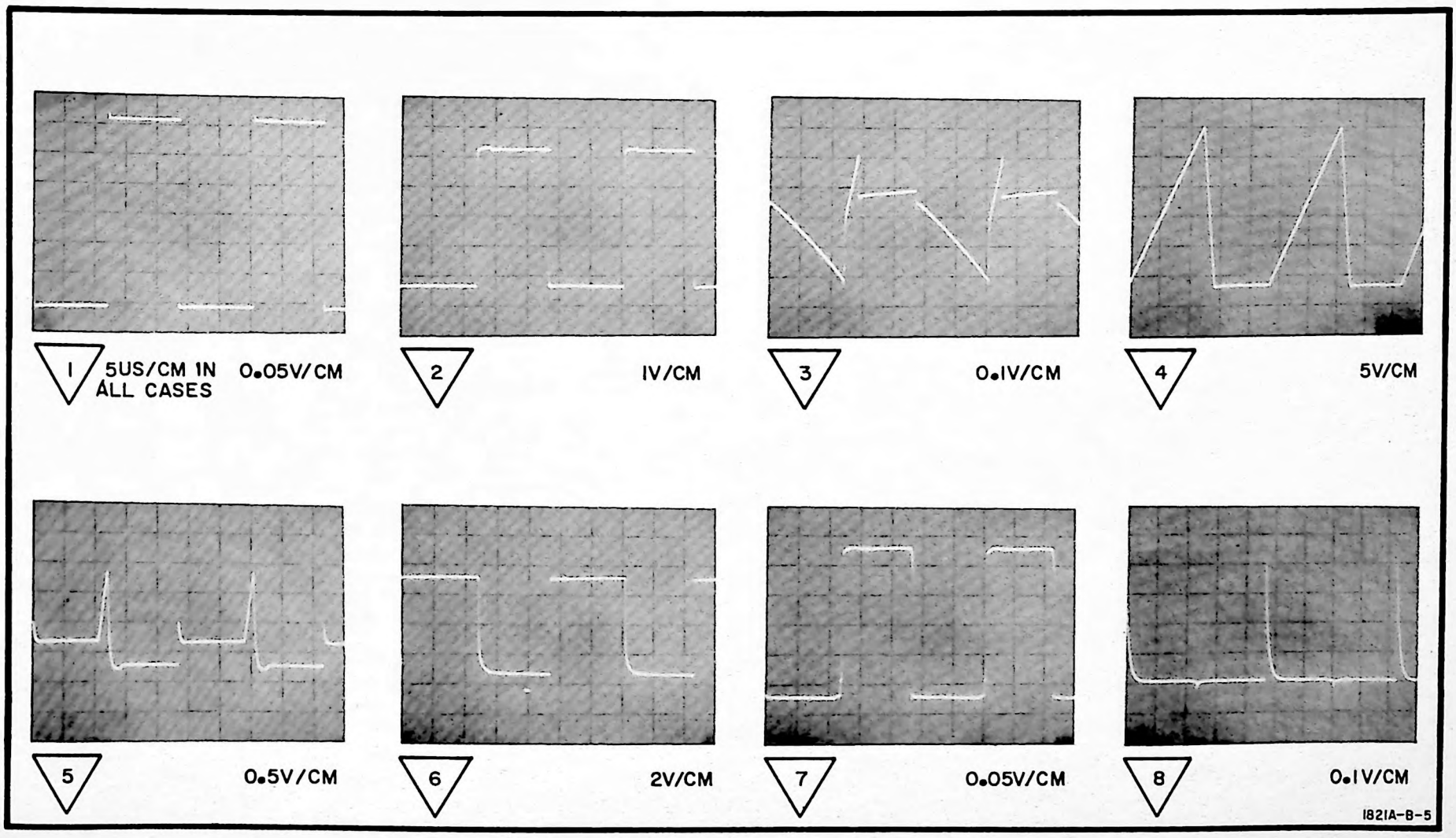
2. Voltages not in parentheses are measured with the following conditions:

Sweep Comparator Circuits.
Ground TP201 and TP401

Gate Amplifier, Gate Inverter, Integrator, Emitter Follower.
Ground TP401.

WAVEFORM MEASUREMENT CONDITIONS

SWEEP MODE	AUTO
main VERNIER	CAL
main TIME/CM	2 μSEC
delayed VERNIER	CAL
delayed TIME/CM	1 μSEC
delayed Trigger Source	AUTO
CM DELAY	5:00



NDITIONS

· · · · · · · INT
· · · · · · · MAIN
· · · 0.2 μSEC
· · · · · · · CAL
· · · · · · · 4:00

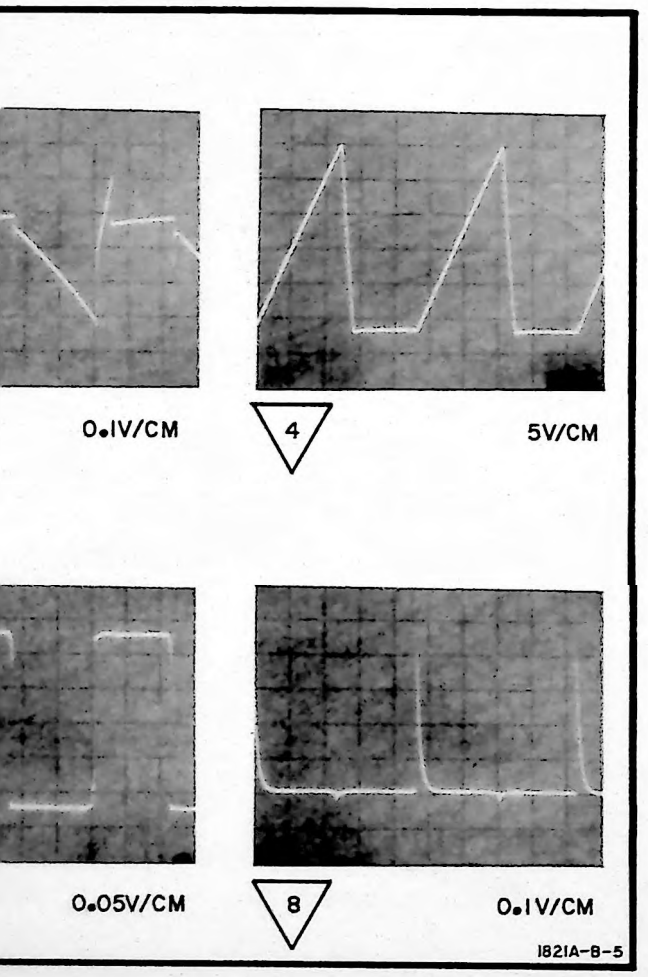
ed with TP401
o -12.6 vdc.

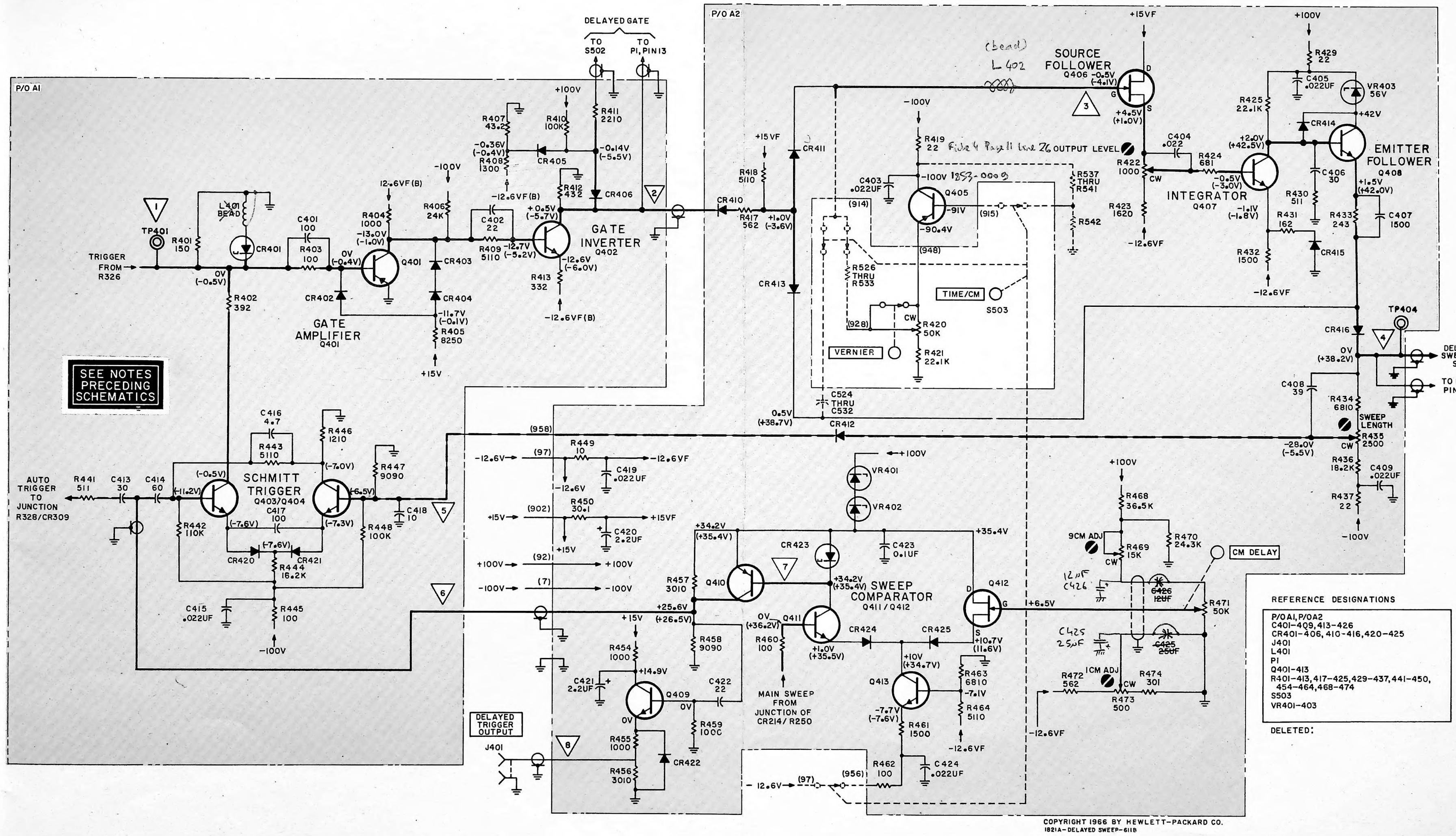
ed with the follow-

or, Emitter Follower.

NDITIONS

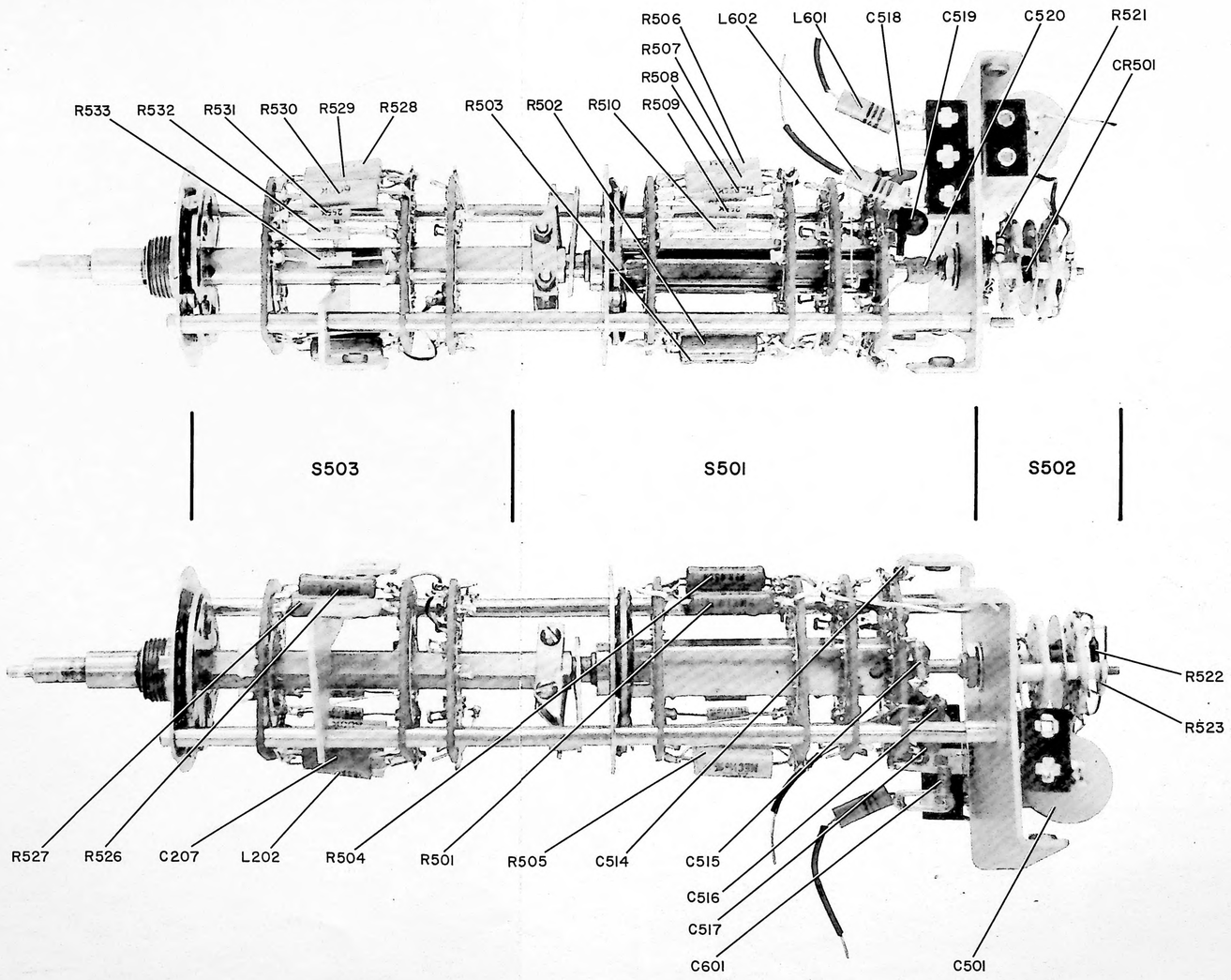
· · · · · · AUTO
· · · · · · · CAL
· · · 2 μSEC
· · · · · · · CAL
· · · · 1 μSEC
· · · · · · AUTO
· · · · · · · 5:00



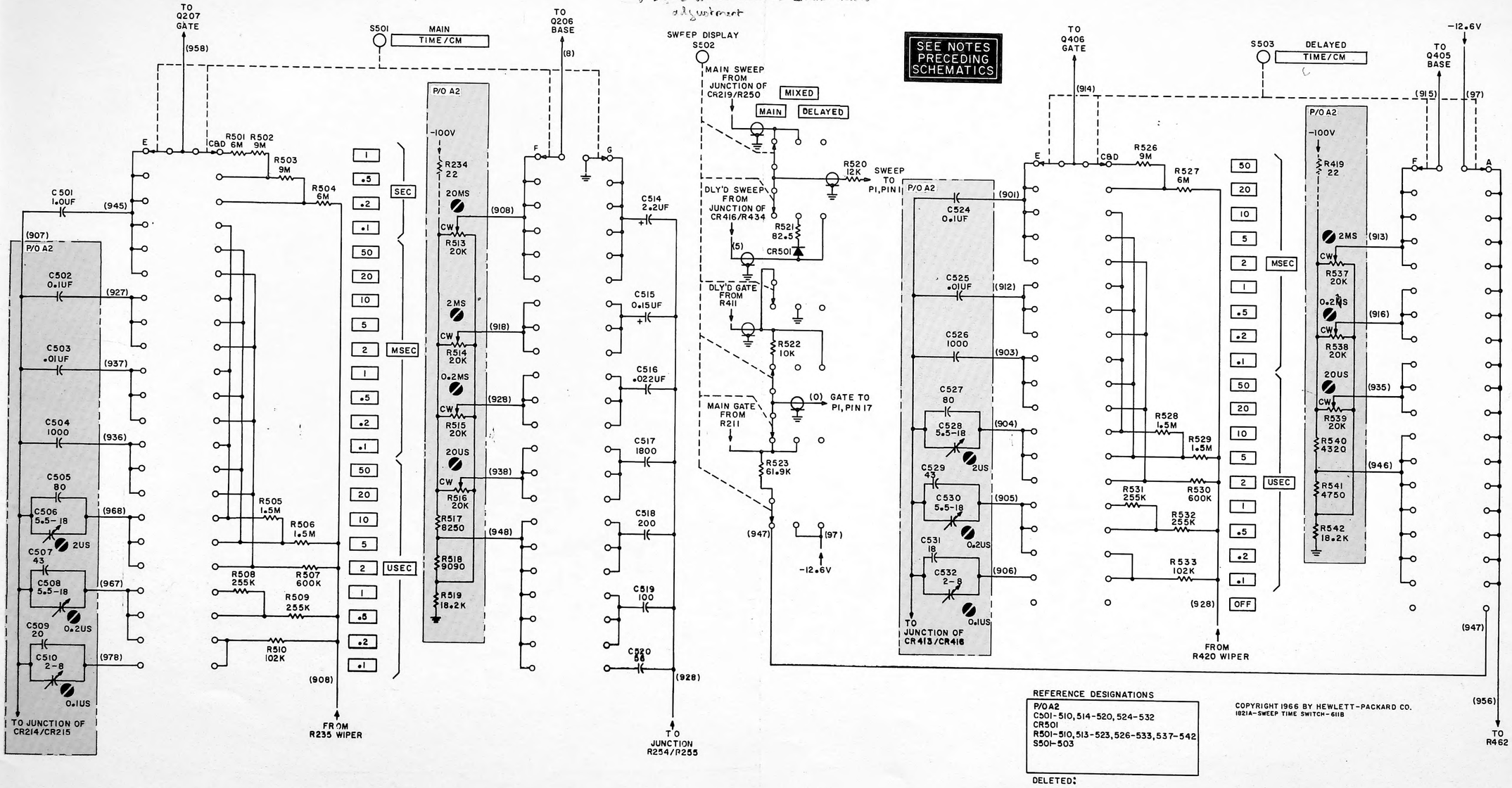


p/o Figure 8-6. Delayed Sweep

Component Identification
for A2 in Figure 8-4



See manual change
Fig 3 for updated schematic
of S502 which includes Intens. Ratio
adjustment



REFERENCE DESIGNATIONS

P/O A2
C501-510, 514-520, 524-532
CR501
R501-510, 513-523, 526-533, 537-542
S501-503

DELETED:

p/o Figure 8-7. Sweep Time Switch

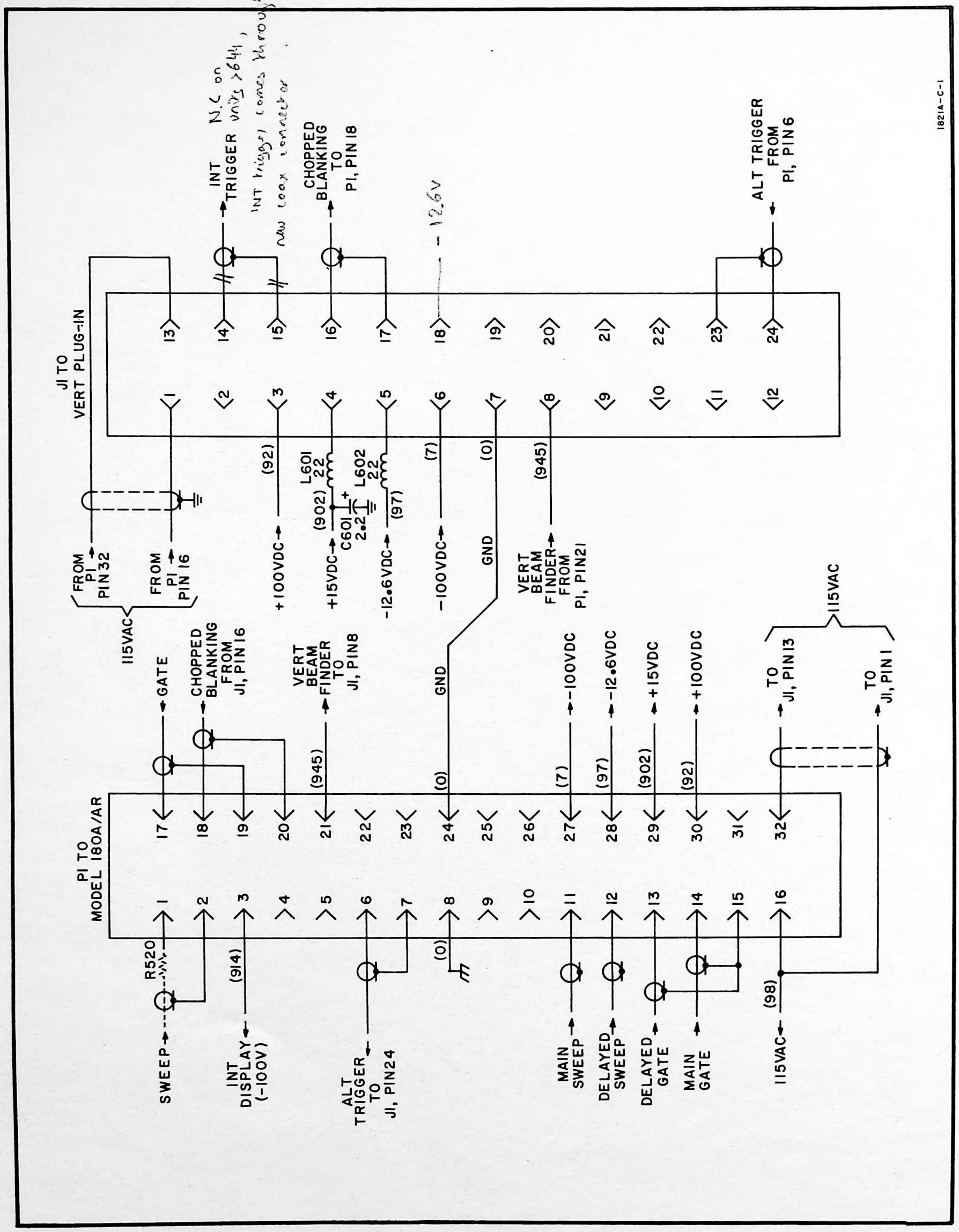


Figure 8-8. Plug and Jack Connections

SALES AND SERVICE OFFICES
UNITED STATES and CANADA

ALABAMA
Huntsville, 35802
2003 Byrd Spring Rd. S.W.
(205) 881-4591
TWX: 510-579-2204

ALASKA
Bellevue, Wash. 98004
11656 N.E. 8th Street
(206) 454-3971
TWX: 910-443-2303

ARIZONA
Scottsdale, 85251
3009 No. Scottsdale Rd.
(602) 945-7601
TWX: 602-949-0111

Tucson, 85716
232 So. Tucson Blvd.
(602) 623-2564
TWX: 602-792-2759

CALIFORNIA
North Hollywood, 91604
3939 Lankershim Blvd.
(213) 877-1282 and 766-3811
TWX: 910-499-2170

Sacramento, 95821
2591 Carlsbad Ave.
(916) 482-1463
TWX: 916-444-8683

San Diego, 92106
1055 Shafter Street
(714) 223-8103
TWX: 714-276-4263

Palo Alto, 94303
1101 Embarcadero Rd.
(415) 327-6500
TWX: 910-373-1280

COLORADO
Englewood, 80110
7965 East Prentice
(303) 771-3455
TWX: 910-935-0705

CONNECTICUT
Middletown, 06457
589 Saybrook Rd.
(203) 346-6611
TWX: 710-428-2036

FLORIDA
Miami, 33125
2907 Northwest 7th St.
(305) 635-6461

Orlando, 32803
621 Commonwealth Ave.
(305) 425-5541
TWX: 305-841-2568

St. Petersburg, 33708
410-150th Ave., Madeira Beach
(813) 391-0211 and 391-1829
TWX: 813-391-0666

GEORGIA
Atlanta, 30305
3110 Maple Drive, N.E.
(404) 233-1141
TWX: 810-751-3283

HAWAII
North Hollywood, Calif. 91604
3939 Lankershim Blvd.
(213) 877-1282
TWX: 910-499-2170

ILLINOIS
Skokie, 60076
5500 Howard Street
(312) 677-0400
TWX: 910-223-3613

INDIANA
Indianapolis, 46205
3919 Meadows Dr.
(317) 546-4891
TWX: 317-635-4300

LOUISIANA
New Orleans
(504) 522-4359

MARYLAND
Baltimore, 21207
6660 Security Blvd.
(301) 944-5400
TWX: 710-862-0850

Rockville, 20852
12303 Twinbrook Pkwy.
(301) 427-7560
TWX: 710-828-9684

MASSACHUSETTS
Burlington, 01803
Middlesex Turnpike
(617) 272-9000
TWX: 710-332-0382

MICHIGAN
Southfield, 48076
24315 Northwestern Hwy.
(313) 353-9100
TWX: 313-357-4425

MINNESOTA
St. Paul, 55114
2459 University Ave.
(612) 646-7881
TWX: 910-563-3734

MISSOURI
Kansas City, 64114
9208 Wyoming Place
(816) 333-2445
TWX: 910-771-2087

St. Louis, 63144
2812 South Brentwood Blvd.
(314) 644-0220
TWX: 910-760-1670

NEW JERSEY
Eatontown, 07724
(201) 747-1060

Englewood, 07631
391 Grand Avenue
(201) 567-3933
TWX: 510-230-9709

NEW MEXICO
Albuquerque, 87108
6501 Lomas Blvd. N.E.
(505) 255 5586
TWX: 910-989-1655

Las Cruces, 88001
114 S. Water Street
(505) 526-2486
TWX: 910-983-0550

NEW YORK
New York, 10021
236 East 75th Street
(212) 879-2023
TWX: 710-581-4376

Rochester, 14623
39 Saginaw Drive
(716) 473-9500
TWX: 510-253-5981

Poughkeepsie, 12601
82 Washington Street
(914) 454-7330
TWX: 914-452-7425

Syracuse, 13211
5858 East Molloy Rd.
(315) 454-2486
TWX: 710-541-0482

Endicott, 13764
1219 Campville Rd.
(607) 754-0050
TWX: 510-252-0890

NORTH CAROLINA
High Point, 27262
1923 N. Main Street
(919) 882-6873
TWX: 510-926-1516

OHIO
Cleveland, 44129
5579 Pearl Road
(216) 884-9209
TWX: 216-888-0715

Dayton, 45409
1250 W. Dorothy Lane
(513) 298-0351
TWX: 513-944-0090

OKLAHOMA
Oklahoma City
(405) 235-7062

PENNSYLVANIA
Camp Hill
(717) 737-6791

West Conshohocken 19428
144 Elizabeth Street
(215) 248-1600 and 828-6200
TWX: 518-660-8715

Monroeville, 15146
Monroe Complex
Building 2
Suite 2
Moss Side Blvd.
(412) 271-5227
TWX: 710-797-3650

TEXAS
Dallas, 75209
P.O. Box 7166, 3605 Inwood Rd.
(214) 357-1881
TWX: 910-861-4081

Houston, 77027
P.O. Box 22813, 4242 Richmond Ave.
(713) 667-2407
TWX: 713-571-1353

UTAH
Salt Lake City, 84115
1482 Major St.
(801) 486-8166
TWX: 801-521-2604

VIRGINIA
Richmond, 23230
2112 Spencer Road
(703) 282-5451
TWX: 710-956-0157

WASHINGTON
Bellevue, 98004
11656 N.E. 8th St.
(206) 454-3971
TWX: 910-443-2303

GOVERNMENT CONTRACTING OFFICE
San Antonio, Texas 78226
Hewlett-Packard
Contract Marketing Division
225 Billy Mitchell Road
(512) 434-4171
TWX: 512-571-0955

CANADA
Montreal, Quebec
Hewlett-Packard (Canada) Ltd.
8270 Mayrand Street
(514) 735-2273
TWX: 610-421-3484
Telex: 01-2819

Ottawa, Ontario
Hewlett-Packard (Canada) Ltd.
1762 Carling Avenue
(613) 722-4223
TWX: 610-562-1952

Toronto, Ontario
Hewlett-Packard (Canada) Ltd.
1415 Lawrence Avenue West
(416) 249-9196
TWX: 610-492-2382

Vancouver, B.C.
Hewlett-Packard (Canada) Ltd.
2184 W. Broadway
(604) 738-7520
TWX: 610-922-5059

5/66

HEWLETT hp PACKARD

SALES AND SERVICE OFFICES
INTERNATIONAL - Electronic Equipment

ARGENTINA
Mauricio A. Suarez
Telecommunicaciones
Carlos Calvo 224
Buenos Aires
Tel. (30-6312) (34-9087)

AUSTRALIA
Sample Electronics (Vic) Pty., Ltd.
9-11 Cremorne Street
Richmond E.1, Victoria
Tel. 42-4757

Sample Electronics (N.S.W.) Pty, Ltd.
4 Grose Street
Glebe, New South Wales
Tel. 69-6338

AUSTRIA
Unilabor H.m.b.H.
Wissenschaftliche Instrumente
Rummelhardtgasse 6/3
P.O. Box 33, Vienna IX/71
Tel. 426 181

BELGIUM
Hewlett-Packard Benelux S.A.
20-24 rue de l'Hopital
Brussels
Tel. 11 22 20

BRAZIL
Ciental Importacao e Comercio Ltda.
Rua des Eliseu Guilherme, 62
Sao Paulo 8
Tel. 70-2318

CHILE
Hector Calcagni
Casilla 13942
Santiago
Tel. 6.42.26

DENMARK
Tage Olsen A/S
Ronnegade 1
Copenhagen 0
Tel. 29 48 00

FINLAND
INTO O/Y
Meritullinkatu 11
P.O. Box 153
Helsinki
Tel. 6 11 33

FRANCE
Hewlett-Packard France
150 Boulevard Massena
Paris 13
Tel. 707 97 19

Hewlett-Packard France
2 rue Tete d'Or
Lyon, 6 - Rhone
Tel. 52 35 66

GERMANY
Hewlett-Packard Vertriebs-GmbH
Kurhessenstrasse 95
Frankfurt a. Main
Tel. 52 00 36

Hewlett-Packard Vertriebs-GmbH
Reginfriedstrasse 13, Munich 9
Tel. 49 51 21

Hewlett-Packard Vertriebs-GmbH
Beim Strohhause 26/28
Hamburg 1
Tel. 24 05 51

Hewlett-Packard Vertriebs-GmbH
(Technisches Buro)
Herrenberger Strasse 110
Böblingen, Wurttemberg
Tel. 6971

Hewlett-Packard Vertriebs-GmbH
Lietzenburger Strasse 30
1 Berlin W 30
Tel. 24 86 36

Hewlett-Packard Vertriebs-GmbH
Achenbachstrasse 15
4 Dusseldorf 1,
Tel. 68 52 58

GREECE
K. Karayannis
Klaftmonos Square
Athens 124
Tel. 230 301

INDIA
The Scientific Instrument Co., Ld.
6, Tej Bahadur Sapru Road
Allahabad 1
Tel. 2451

The Scientific Instrument Co., Ld.
240, Dr. Dadabhai Naoroji Road
Bombay 1
Tel. 26-2642

The Scientific Instrument Co., Ld.
11 Esplanade East, Calcutta 1
Tel. 23-4129

The Scientific Instrument Co., Ld.
30 Mount Road, Madras 1
Tel. 86339

The Scientific Instrument Co., Ld.
B-7, Ajmeri Gate Extn.
New Delhi 1
Tel. 271053

IRAN
Telecom, Ltd.
P.O. Box 1812
Teheran
Tel. 43850, 48111

ISRAEL
Electronics & Engineering Ltd.
Division of Motorola Israel Ltd.
16, Kremenetski Street, Tel-Aviv
Tel. 35021

ITALY
Hewlett-Packard Italiana S.p.A.
Viale Lunigiana 46, Milan
Tel. 69 15 84

Hewlett-Packard Italiana S.p.A.
Palazzo Italia
Piazza Marconi 25, Rome-Eur
Tel. 591 2544

JAPAN
Yokogawa-Hewlett-Packard Ltd.
59, 1-chome
Yoyogi
Shibuya-ku
Tokyo,
Tel. 370-2281

Yokogawa-Hewlett-Packard Ltd.
8, Umeda
Kita-ku, Osaka City
Tel. 313-0091

Yokogawa-Hewlett-Packard Ltd.
4, 3-chome
Himeikedori
Chigusa-ku, Nagoya City
Tel. 751-8545

KOREA
American Trading Co., Korea, Ltd.
Seoul P.O. Box 1103
112-35 Sokong-Dong
Jung-ku, Seoul
Tel. 3.7049, 3.7613

LEBANON
Constantin E. Macridis
Clemenceau Street
Clemenceau Center
Beirut
Tel. 220846

NETHERLANDS
Hewlett-Packard Benelux, N.V.
23 Burg, Roellstraat
Amsterdam, W.
Tel. (020) 13 28 98

NEW ZEALAND
Sample Electronics (N.Z.) Ltd.
8 Matipo Street
Onehunga S.E. 5, Auckland
Tel. 565-361

NORWAY

Morgenstierne & Co. A/S
Ingeniofirma
6 Wessels Gate, Oslo
Tel. 20 16 35

PAKISTAN
Mushko & Company, Ltd.
Oosman Chambers
Victoria Road
Karachi 3, West Pakistan
Tel. 54601

Mushko & Company, Ltd.
Zirat Chambers
31, Jinnah Avenue
Dacca, East Pakistan
Tel. 80058

PANAMA
Electronico Balboa, S.A.
P.O. Box 4929
Panama City
Tel. 3-0833

PERU
Fernando Ezeta B
Av. Petit Thouars 4719
Mira Flores, Lima
Tel. 5-0346

PORTUGAL
Telectra
Rua Rodrigo da Fonseca 103
P.O. Box 2531, Lisbon 1
Tel. 68 60 72

PUERTO RICO
San Juan Electronics, Inc.
Ponce de Leon No. 150, Stop 3
Pta. de Tierra Sta., San Juan
Tel. 725-3342

SPAIN
Ataio Ingenieros
Enrique Laretta 12
Madrid, 16
Tel. 235 43 44-5

SOUTH AFRICA
F.H. Flanter & Co. (Pty.), Ltd.
Rosella House
Buitencingle Street
Cape Town
Tel. 3-3817

F.H. Flanter & Co.,(Pty.), Ltd.
P.O. Box 200, Bramley
775 Pretoria Main Road
Wynberg, Transvaal
Tel. 40-6871

SWEDEN
HP Instrument AB
Centralvagen 28
Solna Centrum
Tel. 08-83 08 30

HP Instrument AB
Box 4028
Indunagatan 28A
Molndal 4
Tel. 27 68 00

SWITZERLAND
Max Paul Frey
Wankdorffeldstrasse 66
Berne
Tel. (031) 42 00 78

TAIWAN
Hwa Sheng Electronic Co., Ltd.
P.O. Box 1558
21 Nanking West Road
Taipei
Tel. 46076, 45936

TURKEY
Telekom Engineering Bureau
P.O. Box 376 - Galata
Istanbul
Tel. 49 40 40

UNITED KINGDOM
Hewlett-Packard Ltd.
Dallas Road
Bedford, England
Tel. 68052

VENEZUELA
Citec, C.A.
Edif. Arisan–Of. No. 4
Avda. Francisco de Miranda
Chacaito
Caracas
Tel. 71.88.05

YUGOSLAVIA
Belram S.A.
83 Avenue des Mimosas
Brussels 15, Belgium
Tel. 35 29 58

For Sales and Service Assistance in Areas Not Listed Contact:

EUROPE
Hewlett-Packard, S.A.
54 Route des Acacias
Geneva, Switzerland
Tel. (022) 42.81.50

ELSEWHERE
Hewlett-Packard
1501 Page Mill Road
Palo Alto, California 94304, U.S.A.
Tel. (415) 326-7000

5/66

HEWLETT hp PACKARD

01821-90901

PRINTED IN U.S.A.